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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wisc., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27. 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretry, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worhsam; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-Ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley, First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting. Chicago, Ill., Dec. 29–31, 1920. President Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock, Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec. 29–31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston. Mass., Dec. 28–30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923–Jan. 2, 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

Thirty-seventh Annual Meeting, Washington, D. C., Dec. 31, 1924–Jan. 3, 1925. President., A. F. Burgess; First Vice-President, M. C. Tanquary; Second Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

Thirty-eighth Annual Meeting, Kansas City, Mo., Dec. 29, 1925–Jan. 1, 1926. President, H. A. Gossard (died in office December 18, 1925); First Vice-President R. N. Chapman (assumed duties of President for remainder of term); Second Vice-President, Leroy Childs; Third Vice-President, C. H. Hadley; Fourth Vice-President, R. L. Webster; Secretary, C. W. Collins.

Thirty-ninth Annual Meeting, Philadelphia, Pa., Dec. 28, 1926–Jan. 1, 1927. President, Arthur Gibson; First Vice-President, C. J. Drake; Second Vice-President, W. B. Herms; Third Vice-President, L. A. Strong; Fourth Vice-President, J. I. Hambleton; Fifth Vice-President, W. E. Hinds; Secretary, C. W. Collins.

Fortieth Annual Meeting, Nashville, Tenn., Dec. 27–31, 1927. President, R. W. Harned; First Vice-President, W. P. Flint; Second Vice-President, R. W. Doane; Third Vice-President, Franklin Sherman; Fourth Vice-President, J. H. Montgomery; Fifth Vice-President, F. E. Millen; Secretary, C. W. Collins.

Forty-first Annual Meeting, New York, N. Y., December 27–31, 1928. President, W. B. Herms; First Vice-President, J. E. Graf; Vice-Presidents, R. S. Woglum (Pacific Slope Branch); G. M. Bentley (Cotton States Branch); P. J. Parrott, (Eastern States Branch); L. S. McLaine, (Section of Plant Quarantine and Inspection); H. F. Wilson, (Section of Apiculture); Secretary, C. W. Collins, Melrose Highlands, Mass.

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Wright, P. F., Box 122, Lodi, Calif.
Wymore, Floyd H., University Farm, Davis, Calif.

†Yeomans, M. S., Cornelia, Ga.
Yetter, W. P., Jr., C. A. C., Fort Collins, Colo.
York, C. H., 136 East Artesia St., Pomona, Calif.
Yothers, M. A., Box 243, Yakima, Wash.
Young, H. C., Box 1257, Tucson, Ariz.
Young, H. D., Bureau Chemistry and Soils, Washington, D. C.

Zeimet, Carlo, Bureau of Entomology, Washington, D. C.

Total Number of Associate Members, 500.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Aulló Costilla, Dr. Manuel, Laboratorio de la Fauna Forestal Espanola, Ferraz, 40 Madrid, Spain.

Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., University of Stellenbosch, Stellenbosch, C. P. South Africa.

Carpenter, Dr. George H., University of Manchester, Manchester, England.
Collinge, W. E., 55 Newhall St., Birmingham, England.

Danysz, J., Laboratorie de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Kolonial Instit., Mauritskade 65–66, Amsterdam, Holland.

Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.

Filipjev, T. N., Certzena 44, Leningrade, Russia.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.

Goding, F. W., Box 448, Livermore Falls, Maine, U. S. A.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.

Herrera, A. L., Director de Estudios, Bibliogicas, Secretaria de Agricultura y Formento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr. G., Museum Nationale Hungaricum, Budapest, Hungary.

†Members who attended 1928 meeting

Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.

Kulagin, Nikolai M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.

Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.

Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., 795 Church St., East, Pretoria, South Africa.

Mally, C. W., University of Stellenbosch, Stellenbosch, C. P., South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokrzecki, Dr. Sigismond, Director, Instit. of Forest Protection and Entomology, Skierniewice, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.

Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.

Parker, Theodore, Leeds University, Leeds, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.

Read, Charles S., Mendoza, Argentine Republic, South America.
Rosenfeld, A. H., Am. Sugar Cane League, 1005 New Orleans Bank Bldg., New Orleans, La.
Ruzkowski, J. W., Solacka, Poznau, Poland.

Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Scaramuzza, L. C., Camaguey, Cuba.
Schoyen, Prof. W. M., Zoological Museum, Christiana, Norway.
Severin, Prof. G., Curator Natural History Museum, Bussels, Belgium.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Stellwagg, Dr. Friedrich, Neustadt, A. d. Haardt, Germany.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand.
Trähärdh, Ivor, Experimental Faltat, Stockholm, Sweden.
Trouvelot, Bernard, Inst. Agri. Research, Paris, France.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.

Urich, F. W., Department of Agriculture, Port of Spain, Trinidad, West Indies.

Total number of Foreign Members, 51
Grand Total of Members, 1,038.

JOURNAL
OF
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 22 FEBRUARY, 1929 No. 1

Proceedings of the Forty-First Annual Meeting of the American Association of Economic Entomologists

The 41st annual meeting of the American Association of Economic Entomologists was held in the Gymnasium, Thompson Hall, Teachers College, Columbia University, New York, N. Y., December 27 to 31, 1928.

The Section of Plant Quarantine and Inspection convened at 10 A. M., December 27 and adjourned at 5:25 P. M. Chairman L. S. McLaine, Ottawa, Canada presided and S. B. Fracker, Washington D. C., was Secretary. In his address as Chairman, Mr. McLaine emphasized the increasing importance of plant quarantine regulations and the necessity of careful scientific investigations as a basis for them. Reports of National and Regional Plant Boards were presented by their officers. Different phases of the plant quarantine operations of the U. S. Department of Agriculture for the past year were discussed in papers by Dr. C. L. Marlatt and Messrs. C. H. Hadley, L. H. Worthley, A. F. Burgess, Max Kisliuk, Jr., and E. R. Sasscer of the Plant Quarantine and Control Administration. Dr. H. H. York presented a paper on "The Woodgate Rust." This was followed by a symposium on the subject "Important State Quarantines." Officers elected for the ensuing year were F. N. Wallace, Indiana, Chairman, and S. B. Fracker continued as Secretary.

The Section of Extension (P. D. Sanders, Chairman; G. F. MacLeod, State College, Pa., Secretary) met on Thursday afternoon. Dr. T. J. Headlee, New Brunswick, N. J. presented a paper on "Administrative Phases of Teaching, Research, Regulatory and Extension Entomology" which was followed by discussion. V. I. Safro presented a paper on "Extension Entomology in Relation to Research;" J. A. Hyslop led discussion on the Insect Pest Survey. At this meeting the Extension Entomologists applied for recognition as the Section of Extension, which was favorably acted upon by the Executive Committee and the

parent Association. J. A. Hyslop was elected Chairman for 1929 and G. F. MacLeod, Secretary.

The Section ot Apiculture (H. F. Wilson, Chairman; E. N. Cory, College Park, Md. Secretary) met Saturday morning. The Section was addressed by the Chairman, followed by presentation of 11 papers dealing with all phases of apiculture. The meeting was well-attended but there was somewhat less interest shown than at meetings held in more favorable beekeeping regions. G. M. Bentley was elected Chairman for 1929 and E. N. Cory continues as Secretary.

The Crop Protection Institute held its annual dinner and business meeting on Thursday evening, December 27.

The program of the main Association opened Friday morning with the usual business session, followed by the address of President W. B. Herms, University of California entitled "Experimental Method as Applied to Entomological Investigations." The speaker discussed many personal observations and experiments conducted in laboratory and field research emphasizing the necessity of paying close attention to fundamentals and details. His paper was discussed freely and evoked much favorable comment. Reading of papers then followed, first being two on "Insects as Biological Controls," followed by 22 on "Insects Affecting Fruits." The latter group covered papers on various phases of banding, spraying,baiting and attrahents for the codling moth, for the lethal dosage to do with larvae and arsenical residues on the fruit. Similar papers dealt with the control of the Oriental Peach Moth, sprays for the Grape Berry Moth, cutworms destructive to blueberries, effects of oil sprays on citrus fruits, history of Mexican fruit worm and bud moth. All these papers were well taken and many discussed with considerable interest. Saturday morning the session opened with the papers on "Insects Affecting Cereal, Forage and Field Crops," which treated leaf hopper injury, tropisms of the Mexican Cotton Boll Weevil, parasites and corn ear worm injury to sweet corn. Five papers were next presented on the European Corn Borer, after which discussion was entered into by Dr. C. L. Marlatt, Chief of the Bureau of Entomology and Plant Quarantine and Control Administration of the Department of Agriculture, at which time he complimented the workers in research and spoke on the damage of the insect reported in the various states and Canada. These papers were followed by five on "Miscellaneous" and two on "Insects Affecting Ornamental Plants." Saturday afternoon nine papers were offered covering various phases of the Japanese Beetle work, including the treatment of nursery plants,

parasites and a mechanical trap as a measure of control. Injury by the beetle and control on a large scale was also discussed with this species and that of the Asiatic beetle in lawns. The next group covered 14 papers dealing with "Insecticides and Appliances." These papers dealt with recent advances with various sprays, dusts and stickers for same; also fumigation. Considerable interest was attracted and they were discussed at length.

The entomologist's dinner was held in the American Museum of Natural History on Saturday evening and was attended by more than 250 members and guests. Dr. W. M. Wheeler, Harvard University, acted as toastmaster, calling for short remarks from several entomologists from various parts of the United States and Canada. The occasion was greatly enjoyed by all.

Monday morning a series of papers was presented dealing with "Insects Affecting Truck Crops" which covered laboratory studies of the digestive enzymes of the potato beetle, field studies on the onion maggot, cucumber beetles and carrot rust fly. Next came two papers on "Insects Affecting Forest and Shade Trees." These papers dealt with a trap for predaceous Calosoma and needs of investigation for shade tree insects. Considerable interest was aroused in the novel trap for obtaining population records of Calosoma beetles with respect to their transfer to other sparsely populated sections. The meeting ended with a final business session with almost 100 new members being voted in. Dr. T. J. Headlee, New Brunswick, N. J., was elected President, E. R. Sasscer, Washington, D. C., First Vice-President and C. W. Collins continued as Secretary.

The business proceedings form Part I of this report, and the addresses, papers and discussions form Part II.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President W. B. Herms at 9:45 A. M., Friday, December 28. About 225 members and visitors attended the sessions.

(A dagger † before the name of a member in the printed membership list indicates that he signed the register as attending the New York meeting.)

PRESIDENT W. B. HERMS: I have the honor of calling to order the 41st annual meeting of the American Association of Economic Entomologists.

The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

Membership in the Association at the time of the Nashville meeting, together with the election of new members, resignations, those dropped for non-payment of dues and losses by death since, is summarized as follows:

	Active	*Associate*	*Foreign*
Total membership, beginning of Nashville meeting.....	414	436	47
Transferred from associate to active membership, Nashville meeting.....	42	−42	
	456	394	47
Members elected, Nashville meeting.....		74	
Re-instatements, " "		8	
Resignations, " "	−1	−5	
	455	471	47
Dropped for non-payment of dues, 1928.....	−9	−24	
Deaths recorded since Nashville meeting.....	−2	−1	−2
Total memebrship, beginning of New York meeting....	444	446	45
Grand Total.....935			
Net Gain..... 38			

C. W. Howard, an active member of the Association, died March 1st, 1928, at Wheaton, Illinois, as a result of a train accident. He was an entomologist of wide experience and had been a member of this Association for a long time. He had spent a number of years teaching at Canton Christian College, Canton, China.

J. Kotinsky, an active member of the Association, died during the winter of 1927–1928. For a number of years he was connected with the U. S. Bureau of Entomology, Division of Forest Insects, and among his publications was Farmers' Bulletin "Insects Affecting Deciduous and Shade Trees and their Control." Later he resigned to enter private business

T. S. Ross, associate member of the Association, born May 16, 1903, died February 5, 1928. He became a member in 1927. He was employed for a period by the U. S. Bureau of Entomology at Tallulah, La., and later went to Cuba, where he became particularly interested in the artificial breeding of the Cuban Tachinid fly parasite of the sugar cane moth borer.

Dr. J. Ritzema Bos, of Holland, a foreign member of the Association, born July 8, 1850, died April 7, 1928. He had been a foreign member since 1894. He had published extensively and rendered a great service to Holland in the field of Zoology and Entomology.

Dr. Claude Fuller, South Africa, a foreign member of the Association, died November 5, 1928. He had been connected with this Association for a number of years. Details of his death and work are lacking at the time of writing this report.

The 13th annual meeting of the Pacific Slope Branch was held at Pomona College, Claremont, Calif., June 14 and 15. The total attendance of 115 was far in excess of that of any other meeting.

The Cotton States Branch held its 3rd annual meeting at Nashville, Tenn., in conjunction with the main Association, and an adjourned meeting at Memphis,

Tenn., February 1 to 3, which was in connection with the annual convention of the Southern Agricultural Workers.

The Northeastern Branch held its first annual meeting after becoming a branch, at Ithaca, N. Y., August 16, during the period of the Fourth International Entomological Congress.

JOURNAL OF ECONOMIC ENTOMOLOGY

Volume 21 of the JOURNAL OF ECONOMIC ENTOMOLOGY has just been completed and contains 960 printed pages, the largest volume in its history. For the first 16 years the JOURNAL contained an average of 515 pages; for the years 1924 through 1927 an average of 830 pages, or an increase of 61%. The JOURNAL for 1928 (Volume 21) with its 960 pages, exceeds the past four year's average by 130 pages or 16%. Printing rates have remained about the same during the last few years but the total paid out has increased annually due to the fact that larger editions are necessary and more pages are being published.

Complete sets of the JOURNAL are still available excepting No. 2 of Volume 1 which is out of print. Volumes 8, 11 and 17 have been selling for $4 each; Vols. 18 and 19 for $4.50 each and Volume 12 for $5.00. A charge of 50 cents for postage is made for each volume going to foreign countries.

It will be necessary to increase the price of some volumes next year as the supply decreases. Members desiring to complete their sets should take advantage of the present rates before the supply becomes further exhausted.

The following table shows the total domestic and foreign subscribers in 1913, 1923, 1927 and 1928:

	1913	*1923*	*1927*	*1928*
Alabama	3	9	8	10
Arizona	7	8	18	20
Arkansas	2	4	7	8
California	34	67	118	127
Colorado	7	12	17	14
Connecticut	10	15	18	19
Delaware	3	3	6	6
District of Columbia	50	55	61	60
Florida	7	15	27	26
Georgia	6	10	13	14
Idaho	2	6	7	7
Illinois	30	31	38	34
Indiana	16	15	18	24
Iowa	5	12	17	18
Kansas	16	16	24	26
Kentucky	4	5	4	4
Louisiana	12	17	26	28
Maine	5	7	10	11
Maryland	11	14	12	14
Massachusetts	48	76	74	71
Michigan	15	10	19	24
Minnesota	10	14	14	12
Mississippi	4	22	34	37
Missouri	8	12	15	13

	1913	1923	1927	1928
Montana	5	7	9	9
Nebraska	3	3	7	8
Nevada	1	2	3	3
New Hampshire	4	9	8	9
New Jersey	14	22	41	44
New Mexico	3	3	4	4
New York	52	69	85	87
North Carolina	6	8	14	19
North Dakota	0	1	1	1
Ohio	22	34	55	57
Oklahoma	2	5	7	6
Oregon	10	12	18	17
Pennsylvania	18	38	46	43
Rhode Island	3	7	4	4
South Carolina	4	2	11	11
South Dakota	1	2	2	2
Tennessee	6	11	14	19
Texas	16	21	39	46
Utah	8	9	12	17
Vermont	1	1	2	2
Virginia	7	16	18	18
Washington	8	8	12	19
West Virginia	5	5	7	5
Wisconsin	6	13	17	17
Wyoming	0	2	5	4
Total for U. S.	520	765	1046	1098
U. S. Possessions	26			
Hawaii		11	11	10
Panama and Virgin Islands		2	2	2
Philippines		5	4	5
Porto Rico & Cuba		7	12	14
Canada	27	47	54	57
Foreign	132	183	285	317
GRAND TOTAL	705	1020	1414	1503

The above table shows a gain of 89 subscribers in 1928 compared with 77 in 1927, 98 in 1926 and 115 in 1925.

INDEX I AND II TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY

The accounts of these two books have been combined since 1925, at which time their indebtedness to the Association was paid off. The sales of these two publications this year amounted to $235, which is slightly more than the receipts in 1927, but in this connection it must be taken into account that in 1927 the volumes sold for $6 each and in 1928 they were reduced to $5.00 and also that the volumes are one year older, hence the reduction in price has to some extent stimulated sales. There are on hand at the present time about 460 or more copies of Index I and about 480 of II. From this combined account, $675 was loaned in 1925 for the publication of Index III, $200 of which was paid back in 1927 and $200 in 1928, leaving a balance of $275 still due this Fund. (See financial statement.)

INDEX III TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY

In the Secretary's report for 1925, it was stated that $1675 was borrowed from the Association, JOURNAL and Indices I and II accounts to assist in financing the publication of Index III. $500 of this was paid back in 1926, $200 in 1927 and $200 this year, leaving a total indebtedness of $775, $275 of which is due Index I and II and $500 to the JOURNAL.

Amount received from sales of this Index in 1927 was $205.15 and $195.50 in 1928. A slight reduction in receipts is noted here but again it must be considered that the price was reduced to $5 per copy in 1928. The lowering of the price somewhat stimulated the sales as the amount received from the lower price almost equalled that of the previous year, even though the index was one year older. There are now on hand for sale about 660 copies of this Index. (See financial statement.)

PERMANENT FUND

At the Philadelphia meeting in 1926, the Association voted that the interest on all deposits be transferred annually to the credit of the Permanent Fund. As a result, in 1927 there was transferred $316.50; in 1928 the sum transferred has grown to $475.99.

The Executive Committee this year approved the transfer to the Permanent Fund of $500 from the Association account and $500 from the JOURNAL account. This is the first time that any money, other than interest, has been transferred from the JOURNAL account to this fund.

No applications for life membership were received in 1928.

ASSOCIATION STATEMENT

Balance in Treasury, November 26, 1927		$1126.72
Amount received from dues and separates		1261.52
Amount received from bank interest		10.00
Paid—Stenographic Report, 1927	$190.73	
Postage	80.48	
Programs and Notices	45.86	
Supplies and Stationery	34.70	
Telegraph and Express	2.90	
Contribution—4th International Entomological Congress	250.00	
Transferred to Permanent Fund	500.00	
Transfer of Interest to Permanent Fund	10.00	
Expenses of Pacific Slope Branch	24.00	
Expenses of Cotton States Branch	23.01	
Returned Checks	4.50	
Secretary	100.00	
Clerical work, Secretary's office	50.00	
Miscellaneous Expenses, Secretary's office	24.75	
	$1340.93	
Balance, November 26, 1928	1057.31	
	$2398.24	$2398.24

Balance deposited in First National Bank, Malden, Mass.

JOURNAL STATEMENT

Balance in Treasury, November 26, 1927		$3858.72
Amount received from subscriptions, reprints, advertising, etc		6244.82
Amount received from bank interest		20.00
Paid—Postage	$338.03	
Printing	3992.78	
Supplies and Stationery	38.45	
Half-tones and engravings	623.64	
Telegraph, Express and Freight	7.07	
Editor	200.00	
Clerical work, Editor's office	100.00	
Clerical work, Business Manager's office	100.00	
Business Manager	100.00	
Back numbers purchased	10.86	
Transferred to Permanent Fund	500.00	
Transfer of interest to Permanent Fund	20.00	
Collection charges and returned checks	7.82	
Miscellaneous Expenses, Business Manager's Office	12.66	
	$6051.31	
Balance, November 26, 1928	4072.23	
	$10123.54	$10123.54
Balance Deposited in First National Bank, Malden, Mass		$2548.47
Balance Deposited in Melrose Trust, Melrose, Mass		1523.76
		$4072.23

INDEX I AND II STATEMENT

Balance in Treasury, November 26, 1927		$767.85
Transferred from Index III		200.00
Received from Sales		235.00
Interest on Deposit		8.05
Paid—Postage	$3.94	
Transfer of Interest to Permanent Fund	8.05	
	11.99	
Balance, November 26, 1928	1198.91	
Balance deposited in First National Bank, Malden, Mass.	$1210.90	$1210.90

INDEX III STATEMENT

Balance in Treasury, November 26, 1927		$21.38
Received from Sales		195.50
Paid—Postage	$4.48	
Transferred to Index I and II	200.00	
	$204.48	
Balance, November 26, 1928	12.40	
	$216.88	$216.88

Balance deposited in First National Bank, Malden, Mass.

INDEBTEDNESS OF INDEX III

Index III owes Index I and II	$275.00
Index III owes JOURNAL	500.00
Total indebtedness	$775.00

PERMANENT FUND

Balance, Melrose Savings Bank, November 26, 1927	$3739.05
Interest on Deposits, Melrose Savings Bank	169.99
Interest on Liberty Bonds	63.75
1928 Interest from First National Bank, Malden, Mass. (Accounts: Indices I and II, III, JOURNAL, Assoc.)	38.05
1928 Interest from Melrose Trust Company, Melrose, Mass. (JOURNAL account)	61.84
Interest, Certificate of Deposit, First National Bank, Malden (Accounts: Indices I and II, JOURNAL, Assoc.)	142.36
Paid into Permanent Fund from Association	500.00
Paid into Permanent Fund from JOURNAL	500.00
Amount realized from sale of Liberty Bond	100.00
	$5315.04
4¼% Liberty Bonds	1500.00
GRAND TOTAL	$6815.04

SUMMARY

Balance in Indices I and II Account, November 26, 1928	$1198.91
Balance in Index III Account, November 26, 1928	12.40
Balance in JOURNAL account	4072.23
Balance in Association account	1057.31
GRAND TOTAL	$6340.85

Respectfully submitted,
C. W. COLLINS, *Secretary*

Voted that the report be accepted.

PRESIDENT W. B. HERMS: Next is the report of the Executive Committee.

REPORT OF EXECUTIVE COMMITTEE

The Executive Committee begs to submit the following report:

Immediately on assuming office the President of the Association appointed R. W. Harned as chairman of the Committee on Policy.

By resolution adopted at the Nashville meetings the President was instructed to appoint a committee of five to deal with the matter of training entomologists, "this committee to confer upon the requirements of the several fields as well as the essentials of foundational training, and to present to this Association, at its next meeting, a tentative list of subjects that should be included in the training of an entomologist, including both foundational and specialized items with their proportionate weight in such training." The following committee was appointed to serve in this capacity, viz., W. C. O'Kane, Chairman, H. J. Quayle, A. C. Baker, C. J. Drake and W. A. Riley.

By resolution also adopted at the Nashville meeting, the President was instructed to appoint a committee of three to present to the Secretary of Agriculture the needs for the further establishment and development of field stations in foreign countries for the purpose of studying insect pests, plant diseases and animal diseases already introduced or likely to be introduced into this country. This committee to cooperate with a similar committee to be appointed by the Phytopathologists. The President appointed the following committee: P. J. Parrott, Chairman, T. J. Headlee, W. J. Schoene, with J. E. Graf as consultant.

On recommendation of the Editorial Board and the Secretary, the Executive Committee approved the transfer of $500.00 from the JOURNAL account to the Permanent Fund. Also, on recommendation of the Secretary, the sum of $500.00 was transferred from the Association funds to the Permanent Fund.

On recommendation of the Secretary, the price of the indices was reduced from $6.00 to $5.00 domestic, and from $6.50 to $5.50 foreign.

The sum of $250.00 was voted from the treasury of the Association to assist in defraying the expenses of the Fourth International Congress of Entomology at Ithaca, N. Y., Aug. 12–18, 1928. The Executive Committee takes this opportunity to congratulate the General Committee on local arrangements for the splendid success of this great congress of entomologists.

Vice-President G. M. Bentley was appointed to officially represent the Association at the meetings of the Cotton States Branch held at Memphis, February 1–3, 1928. His report of the meeting indicates a very satisfactory condition of this branch.

The President of the Association attended the meetings of the Pacific Slope Branch at Pomona College, Claremont, California, June 13–16, 1928. Second Vice-President R. S. Woglum presided at these meetings. This branch continues to flourish, the secretary reporting the largest attendance in the history of the Branch.

Vice-President P. J. Parrott presided at the first meeting of the newly established Eastern branch of the Association held at Ithaca, N. Y., Aug. 14, 1928 in conjunction with the Fourth International Congress of Entomology. The interest displayed indicates that this will become one of the strongest branches of the Association.

An application was received from the Extension Entomologists to become a section of the American Association of Economic Entomologists to be known as the

Section of Extension. This application is attached as a part of this report. It was also referred to the Committee on Policy. The Executive Committee unanimously recommends that the application for the formation of the Section of Extension be approved by the Association.

The Executive Committee has audited the books of the Secretary and found them to be correct and proper endorsement has been made in the cash book.

Respectfully submitted:

W. B. HERMS P. J. PARROTT
J. E. GRAF L. S. MCLAINE
R. S. WOGLUM H. F. WILSON
G. M. BENTLEY *Executive Committee*

APPLICATION OF THE EXTENSION ENTOMOLOGISTS TO BECOME A SECTION OF EXTENSION OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Since 1921 the Extension Entomologists, by arrangement with those Entomologists interested in the insect pest survey, have met each year at the time of the annual meeting of the American Association of Economic Entomologists. The first few meetings were more or less informal but it was recognized by those who participated that substantial benefit was secured from the contacts made. During the last few years interest has increased in this activity and several meetings have been held and formal papers were presented. At the present time this group has contacts with the Extension Departments in 26 different States and interest in the subject is constantly increasing. It appears that the extension field is destined to be one of growing importance to Entomologists and that the time has arrived when a more definite form of organization is highly desirable.

The Extension Entomologists would therefore request that they be admitted as a section of extension of the American Association of Economic Entomologists and given the same recognition as the existing sections.

It is of course understood that the Extension Entomologists will cheerfully conform to the wishes of the Association relative to the time that can be allotted for their session at the annual meeting, and that the publication of their proceedings and papers in the JOURNAL will be arranged with the editorial board of that publication so that the printed matter will not occupy an excessive amount of space.

It is believed by the special committee who have carefully considered this matter, that the formation of the proposed section will be of mutual advantage to all conerned and it is therefore requested that this application be given favorable consideration by the Association.

REPORT OF THE SPECIAL COMMITTEE RELATIVE TO APPLYING TO THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS TO BE CONSTITUTED AS A SECTION OF EXTENSION OF THAT ORGANIZATION

At the request of the officers of the Extension Entomologists, the undersigned committee have considered the desirability of requesting the Association of Economic Entomologists that this group be constituted an extension section of that Organization.

The matter has been considered carefully and it is believed that an arrangement of this sort would be mutually advantageous. It would give the Extension Ento-

mologists definite recognition as a part of the National Organization as well as the other advantages enjoyed by the two existing sections.

It is believed that favorable action would strengthen the Association by adding support and increasing interest in its work and that it would tend to unite more closely the Entomologists who are engaged in extension work with those whose chief interest lie in research, control and other important phases of Entomology.

The committee recommends that immediate action be taken to accomplish this purpose and submits herewith a definite proposal to be presented to the American Association of Economic Entomologists.

A. F. BURGESS, *Chairman*
V. I. SAFRO
W. E. HINDS
E. G. KELLY
R. W. HARNED
Committee

Voted that the report be adopted.

PRESIDENT W. B. HERMS: At this point there should have been designated a report from the Committee on Amendments to the Constitution. This Committee consists of P. A. Glenn, F. L. Thomas and A. F. Burgess. Will Mr. Burgess please make the report?

Mr. Burgess stated that the Committee recommended last year that Section 1, Article III, be amended by the substitution of the following phraseology:

"The officers shall consist of a president, one vice-president, and an additional vice-president for each branch or section, who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the By-laws. *The president and the last two ex-presidents and the Secretary of the Association together with three members, one of whom shall be elected annually for a term of three years shall constitute the executive committee, provided that at the first election after the adoption of this amendment three persons shall be elected as members of the executive committee, one for one year, one for two years, and one for three years, and provided further that on the adoption of this amendment the retiring president shall retain membership on the executive committee for two years after the expiration of his term and the ex-president who next preceded him shall be a member of the committee for one year. The executive committee* shall pass on any urgent matters that can not be deferred until the annual meeting. The president shall not hold office for two consecutive terms."

Respectfully submitted,

A. F. BURGESS, *Chairman*
P. A. GLENN
F. L. THOMAS
Committee

Voted that the amendment be adopted.

PRESIDENT W. B. HERMS: Next is the report of the Representative to the National Research Council, by Dr. W. A. Riley.

Dr. Riley was not present and no report was given.

PRESIDENT W. B. HERMS: Next we will hear the report of the Committee on Policy.

REPORT OF THE COMMITTEE ON POLICY

The personnel of the sub-committees for the year is as follows:

Publicity—Messrs. Burgess, Collins and Felt.

Insecticides and Appliances—Messrs. Haseman, Felt and Ruggles.

Regulatory and Control—Messrs. Ruggles, Gibson and Burgess.

Technical Training and Research—Messrs. Riley, Herms and Harned.

The sub-committee on Regulatory and Control believes that the work now carried on by the National and Regional Plant Boards adequately covers the field.

The sub-committee on Technical Training and Research is not reporting this year as the Chairman, Dr. Riley is also a member of the special committee of five appointed by the President in response to a resolution adopted by the Association last year. Professor O'Kane is Chairman of this special committee.

The sub-committee on Insecticides and Appliances has submitted a report that we recommend for publication.

We recommend that hereafter the representatives of this Association elected to serve on the National Research Council take over all the duties that were heretofore exercised by the Committee on Cooperation.

The application from the Extension Entomologists to the Association regarding the creation of an additional section to be known as the Section of Extension is approved by the Committee on Policy.

Inasmuch as the executive committee has been reorganized by action just taken by the Association, it is recommended that the Committee on Policy be discontinued.

Respectfully submitted,

A. G. RUGGLES
A. F. BURGESS
L. HASEMAN
ARTHUR GIBSON
W. A. RILEY
E. P. FELT
C. W. COLLINS
W. B. HERMS
R. W. HARNED

Committee

REPORT SUB-COMMITTEE ON INSECTICIDES AND APPLIANCES

It is evident that the economic entomologists are not satisfied with the present available insecticides and appliances. This is clearly shown by the amount of investigational work now being done along these lines. The stomach poisons fall short of what is expected of them and the arsenicals, particularly arsenate of lead which comes nearest to meeting needs, is undesirable because of spray residue. Likewise the contact insecticides have their shortcomings. The same thing may be said of the present available gases, repellents, attractants, and spraying and dusting equipment. In other words, we admit that we are waging war, with faulty equipment and unsatisfactory supplies and materials. To complicate matters our markets continue to be flooded with new unproved chemicals and appliances. A glance at the patent office reports will show each year a surprising number of new patented appliances and chemicals for warfare against insects.

When we consider the fact that many of our present standard insecticides have been more or less accidentally discovered, often by those with no claim for scientific

training, we are not surprised at the present movement looking to a thorough investigation of the entire fields of chemistry and physics with its X-ray and electricity for possible solution of our present insecticide and appliance problems. The next few years will undoubtedly bring marked improvement in these lines.

During the year just closing a great deal of research work in this field has been conducted and some of this has been briefly summarized for this report on insecticides and appliances. For the sake of brevity this will be presented as a progress report for the year without any effort to give credit to the numerous individuals who have kindly submitted reports on their investigations.

Contact Chemicals

Of the contact chemicals the oils have received most attention, particularly their use as summer sprays. Laboratory and field tests on the effect of mineral, animal and vegetable oil emulsions on the eggs and on oviposition by the European corn borer show some promise of possible future use of oil emulsions in corn borer control work. Investigations are under way dealing with the effect of surface tension on toxicity and penetration of contact insecticides. Also combinations of oils and derris, pyrethrum and nicotine have received further studies and in some experiments these have given very effective results though they are expensive. Pyrethrum, derris and nicotine have been given special attention as remedies for pests of livestock and poultry and have proven satisfactory for some of the pests.

Fish oil has been given special attention as a spreader and sticker with arsenicals.

Calomel as a substitute for corrosive sublimate has proven effective as a control for cabbage maggots. Also the onion maggot has been kept under control by the use of several different emulsions.

Stomach Poisons

During the year no new outstanding developments along the line of stomach poisons were reported and no effective substitutes were found for arsenate of lead. Cuprous cyanide in laboratory and field tests proved to be nearly as effective as arsenate of lead though it caused foliage and fruit injury. The fluosilicates, fluorine, cryolite and the other arsenicals all proved inferior to arsenate of lead as orchard sprays. Some reported dosages greater than one pound to fifty gallons of spray necessary for effective codling moth control while other experiments showed this dosage effective.

Investigations on comparative toxicity of various materials are of vital importance in the search for an effective substitute for arsenate of lead.

Gases

Calcium cyanide for generating hydrocyanic acid gas has received further attention in fumigation of homes and dairy barns for flies. Miscible carbon bisulphide has proven much surperior to carbon bisulphide emulsion. In Connecticut arsenate of lead applied in water has supplanted carbon bisulphide emulsion for treating lawns.

Repellents

Investigations with repellents more especially for the Japanese beetle have been conducted and a number of materials, with o-cresol, pine tar oil, Dippel's oil and phenol heading the list, have given some promise.

Attractants and Baits

Attractants and baits have been given special attention in connection with the control of the codling moth. Investigators report varying degrees of effectiveness for the different baits. They agree that baits for the codling moth are most useful in determining dates of moth emergence and as a supplement to the control with sprays. Drainalt's solution, fermented fruit juice and fermented molasses have been used as codling moth baits. Various odors other than fermentation are reported as attractive to codling moths.

Drainalt's solution and fermenting thin syrup have also proven effective as attractants for cut-worm moths. Encouraging results in the control of a number of insects are reported from the use of sweetened baits on cotton. Iso-amyl valerate, ethyl malonate and oil of thyme were also reported as effective in attracting flies, wasps and beetles.

Codling Moth Bands

From the use of chemically treated bands for the control of apple worms the widest variation in results were reported. Some reported very good results with bands treated with beta-naphthol dissolved in lubricating oil while others reported the same type of band ineffective. Some reported that climatic conditions seemed to reduce the period during which this type of band was effective. Burlap, crepe paper and corrugated paper were used as bands.

Appliances

Further developments in the use of stationary orchard spraying outfits, the liquiduster, dusting machines and electric apparatus for electrocuting insects were the outstanding developments reported in the field of appliances. Some work has been under way looking to the possible use of radium, the X-ray and other rays but nothing outstanding was reported.

Respectfully submitted,
L. Haseman
E. P. Felt
A. G. Ruggles
Sub-committee

Voted that the report be accepted and the recommendations adopted.

President W. B. Heems: Next is the report of the Trustees of the Crop Protection Institute.

REPORT OF BOARD OF GOVERNORS OF THE CROP PROTECTION INSTITUTE

By W. C. O'Kane, *Chairman*

Twenty-one research projects have been under way in the course of the calendar year 1928. These have covered a wide range of subjects and have occupied a staff of investigators, most of whom have been employed on a full-time basis.

The supporting companies and associations include the following:

American Association of Nurserymen, The Bayer Co., Inc., The California-Spray-Chemical Co., The Interstate Chemical Co., The Kay Laboratories, Inc., The Koppers Co., The Nichols Copper Co., The Quaker Oats Co., The Standard Oil Co., In-

diana, The Standard Oil Co., New Jersey, The Tennessee Copper & Chemical Corporation.

The work has been done in cooperation with the experiment stations and universities, or other research institutions, in the following states:

New Hampshire, Connecticut, New Jersey, New York, Maryland, North Carolina, Florida, Ohio, Indiana, Illinois, Wisconsin, Iowa, Kansas, and Colorado.

As in the past, the Institute's activities have been directed by a Board of Governors named by national scientific societies, and by the National Research Council. The membership of the Board for the year 1928 has been as follows:

Dr. E. D. Ball, of Arizona, Mr. W. P. Flint, of Illinois, Prof. P. J. Parrott, of New York, Prof. W. C. O'Kane, of New Hampshire, Dr. J. F. Adams, of Delaware, Dr. I. E. Melhus, of Iowa, Dr. H. W. Anderson, of Illiniois, Dr. B. L. Hartwell, of Massachusetts, and Director H. J. Patterson, of Maryland.

Much of the research work in progress in 1928 will continue in 1929. In addition, there are six or seven new projects pending at the present time, three of which have been definitely authorized.

Voted that the report be accepted.

PRESIDENT W. B. HERMS: We will now listen to the report of the Scientific Trustee, Tropical Plant Research Foundation.

REPORT OF SCIENTIFIC TRUSTEE OF THE TROPICAL PLANT RESEARCH FOUNDATION

During the year since my last report there have been no very radical changes in the work of the Foundation, but considerable progress has been made in carrying forward the projects of the Foundation.

The principal laboratory at Baraguá is the center of most of the scientific work but members of the staff have been occupied at times in other localities, and Mr. Plank's work on the sugar cane borer has been continued at Jaranú. Some further work has been done on the Tropical Forest studies in connection with the grant from the Pack Foundation. Most of the work, however, as heretofore, has been with the support of the Cuba Sugar Club and the work of special interest for this society pertains to the investigations upon the insects affecting sugar cane.

As reported by the director the following is the plan for the projects of the current year:

A continuation of the work on the insect transmission of sugar cane mosaic, to include:

"1. The host plants of aphis, other than sugar cane in respect to (a) preference of aphis for them, (b) their seasonal ability to support aphis life, and (c) their comparative distribution over the Island.

2. The seasonal flight or activity of aphis as determined by stations at Baraguá, Portugalete, Rio Caùto, and Jatibonico. Comparison of such activity with spread of mosaic.

3. Corn as a host plant of aphis, its influence on the spread of mosaic, in cooperation with Dr. Faris.

4. Other mosaic diseases, such as the corn stripe disease, and the insects which convey them.

5. The susceptibility of cane varieties to mosaic infection as determined under cage conditions with aphis, including tests with other species of insects.

6. Consideration of mosaic control by (1) natural enemies of aphis, and by (2) control of host plants of aphis other than cane.

The investigations on the moth stalk borer:

1. The status of the borer in Cuba, mill and field losses, any variation in the amount of infestation in different sections and the factors responsible for them.

2. The plantation measures that help to reduce borer injury.

3. The parasites of the borer that occur in Cuba, their distribution and the extent to which they exercise natural control, together with the possible means by which their efficiency can be increased by (a) extending their distribution over the Island or by (b) increasing their abundance.

4. A review of the borer parasites of other countries to determine those which do not occur in Cuba and the possibility (a) of obtaining them, (b) of cooperation with other countries interested in the same subject, and (c) the most hopeful fields for exploration work.

Other insects injurious to sugar cane in Cuba:

The general survey to determine the sugar cane insects of Cuba will be continued. As far as time and funds will permit, observations and studies will be made on their identity, injury, and distribution. The soil insects, such as white-grubs, wire-worms, mealy-bugs, etc., are an important group, and consideration of them will be continued.

The dusting work for the direct control of the borer did not show sufficient promise to warrant recommendation as a field practice and the tests were discontinued. It is suggested, however, that the station at Central Jaronú be continued for the intensive study of the Cuban parasites of the borer, since we have two season's observations at that place and any additional information gained on their seasonal occurrence, comparative abundance and relative efficiency would be of added value. This intensive work will be supplemented by general survey over the Island as a whole."

The members of the staff engaged in Entomology are the same as heretofore except for the loss by death of Mr. Ross. Aside from the resident director, D. L. Van Dine, whom we all know as a competent Entomologist, Mr. C. F. Stahl as chief Entomologist is giving his main attention to the insects associated with the mosaic disease, Mr. H. K. Plank, to the cane borer and Mr. L. C. Scaramuzza as assistant. The vacancy caused by the death of Mr. Ross has not been filled and I understand an effort is being made to secure a competent man with special reference to the collection of parasites.

An arrangement has been entered into with the Pan American Union whereby the director of the Foundation is authorized to act as a technical advisor to the Union in relation to problems in agriculture.

The publications for the year include a bulletin on the lesser corn stalk borer and a letter of information upon the same insect, both by Mr. Plank, and one on wire worms causing injury to sugar cane by Mr. C. F. Stahl issued late in 1927 as also bulletins No. 5 and 7, in Spanish, relating to mosaic and corn aphis. Copies of these bulletins may doubtless be obtained from the Foundation by those who may be specially interested.

The entomological problems connected with Tropical Agriculture are of tremendous importance and of vital interest to our members. Your representative will be very glad to answer any questions concerning the scope of the work in the Foundation

and Officers of the Foundation will, I am sure, be very glad to furnish information to any one.

HERBERT OSBORN
Scientific Trustee

Voted that the report be accepted.

PRESIDENT W. B. HERMS: Next is the report of the Representative on the Council of the Union of American Biological Societies.

No report was given.

Mr. George A. Dean, Representative on the Council of the American Association for the Advancement of Science, suggested that Dr. Herbert Osborn had a brief and very interesting report which had been received with intense interest that morning at the Council meeting, on the work of Biological Abstracts.

MR. HERBERT OSBORN: A very complete and comprehensive report was made on the activities of Biological Abstracts and the status of the publication at the present time. All of you who receive the abstracts probably know that the publication has been somewhat delayed. There are now ten numbers out, including all of Volume I except the index and two numbers of Volume II, bringing matters up pretty well into 1927. Those publications will come out probably much more rapidly in the near future. Biological Abstracts receives $50,000 a year from the Rockefeller Foundation, that being contingent for seven years, a total of $350,000 is available for the overhead work of the abstracts. They have received somewhere near $50,000 from subscriptions from libraries and subscribing members, so they have had funds to carry forward that work with a considerable staff.

The difficulties of publishing biological abstracts are evidently much greater than for chemical abstracts, because of the great diversity of matter that is included in the biological field. You see we have all of our economic entomology and various phases of biologic work and it takes in bacteriology and plant pathology and all the other phases of biology, and especially with the taxonomic papers, it makes it a very complicated matter to abstract. I think those of you who have been following the published abstracts will recognize those abstracts have been very carefully done. The index, of course, will be of great help in the use of the abstracts. That will be out probably in a short time.

While we cannot say the enterprise has been absolutely established and put on its feet for good, I think we have made considerable progress and it deserves every help that can be given to it in the way of extending the subscriptions and increasing the income for the work.

PRESIDENT W. B. HERMS: We will now have the report of the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

MR. PRESIDENT:

This committee begs to report that in conformity with instructions received at the last regular meeting of this Association, a list of 11 names was submitted to the Association for its approval. Of these 11 names 6 were finally approved and published as the third supplement to the list appearing in Volume 18, p. 521–545. This supplement appears in Volume 21, p. 788–789.

During the current year the Committee has received suggestions for common names for several insect pests, and in reviewing literature it has found that several more very important insects are without names approved by the Association. This committee, therefore, submits a list of thirteen common names for the consideration of the Association.

Several of these names have been presented to the Association on previous occasions and have failed to be adopted. Two of these names in particular, should have your careful consideration. One being *Laspeyresia molesta* and the other *Tetranychus telarius*.

Inasmuch as in the time at our disposal it is impossible to adequately consider these names at this meeting, your committee suggests that it be instructed to send a copy of this list of names to each active member of the Association for his or her consideration and that it be the sense of this meeting that all names on this list which have not received on or before May 1, 1929, five or more objections be considered as approved and that the approved names be published in Volume 22 of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Respectfully submitted,
J. A. HYSLOP, *Chairman*
E. O. ESSIG
F. C. BISHOPP
H. B. HUNGERFORD
H. G. CRAWFORD
Committee

Voted that the report be adopted.

PRESIDENT W. B. HERMS: We will now listen to the report of the Committee on Endowment.

REPORT OF COMMITTEE ON ENDOWMENT

The balance in the permanent fund at the last annual meeting was $5,339.05. This has been increased during the present year by transfers of cash and interest from other funds amounting to $1,475.99, which makes the present balance $6,815.04 as is shown in detail by the report of the Secretary and the Trustees.

The committee has not succeeded during the past year in increasing the fund by obtaining donations or by funds received from life membership fees, as no members have applied for life membership.

Out of a membership of over 900 there are at present five life members whose fees have been placed in the permanent fund. The best argument that can be used to secure help from outside sources is that the members are doing their part in support-

ing this project. Such support has not been forthcoming up to the present time and unless more interest is taken substantial progress cannot be made. We again urge your coöperation in furthering this cause.

Respectfully submitted,
A. F. BURGESS
J. G. SANDERS
G. A. DEAN
Committee

Voted that the report be accepted.

PRESIDENT W. B. HERMS: The next is the report of the Editorial Board on Index to American Economic Entomology.

REPORT OF EDITORIAL BOARD ON INDEX TO AMERICAN ECONOMIC ENTOMOLOGY

Your Committee reported last year to the effect that conditions were favorable for the compilation of another Index provided it was started shortly and it was finally decided to recommend this, leaving the matter of publication for solution later.

Your committee is informed that compilation from 1925 to date for the American Entomological Periodicals, the publications of the various State Experiment Stations, the publications of the U. S. Department of Agriculture, The U. S. National Museum and a selected list of American Farm papers is practically complete, making a total of some 15,000 references which are filed in the Federal Bureau library and are in constant use in reference work. The five year period for the Index would end December 31, 1929 and therefore, the next year and a half is the crucial period. We are advised that the Bureau library has never been given the assistance to push the project intensively until the Association assumed responsibility for publication if the work was properly and promptly prepared, therefore, if this volume is to be published it is very desirable that some definite authorization be given at the present time.

The financial condition of Indexes I to III indicate that another number can be published without financial embarrassment, although the returns from the preceding issues have not been large. Furthermore, it should be borne in mind that if the series is not continued, the probabilities are against Entomologists being able to secure the preparation of copy in the future by governmental agencies. Action favorable to the publication of Index IV should be construed as involving a personal responsibility on the part of many Entomologists to support the Index by individual subscriptions.

In view of the importance of the early publication of the Index, the committee recommends that it be authorized to make arrangements for the completion of the manuscript early in 1930 along substantially the same lines as in preceding Indexes and that the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY be authorized, in its discretion, to proceed with the publication of the Index and to fix, as heretofore, the price of copies.

Respectfully submitted,
E. P. FELT
W. E. BRITTON
C. W. COLLINS
Editorial Board

MR. E. P. FELT invited free discussion before the Association commit itself to publication of another Index.

SECRETARY C. W. COLLINS drew attention to the fact that the indices as a whole could not be considered a very profitable undertaking for the Association but stated that the three indices as a whole to date had paid off their indebtedness with a small surplus and with a supply of 400 to 600 copies of each Index on hand for sale.

MR. A. F. BURGESS spoke favorably of the project, stating that the Association was in a better position at this time to publish the data than it might be for quite some time to come and furthermore that the Bureau of Entomology is willing to compile the references as they had done for the previous indices.

Voted that the report be adopted.

PRESIDENT W. B. HERMS: The next is the report of the Board of Trustees for the Permanent Fund.

REPORT OF BOARD OF TRUSTEES FOR THE PERMANENT FUND

At the Philadelphia meeting in 1926, the Committee on Policy recommended, and the Association voted, "to create a Board of Trustees for the Permanent Fund which shall have charge of all moneys placed in this fund and shall be responsible for their proper investment."

Provision was first made for a permanent fund at the Toronto meeting in December, 1921, and it has grown from $1334.75 to $6815.04 at the end of 1928, as follows:

Deposit, Melrose Savings Bank, Nov. 26, 1927	$3739.05
Interest Credited in 1928	475.99
Transferred from Association, 1928	500.00
Transferred from JOURNAL, 1928	500.00
Liberty Bond matured and transferred to this fund	100.00
	$5315.04
4¼% Liberty Bonds	1500.00
GRAND TOTAL	$6815.04

Growth of this fund is shown as follows:

1922	$1334.75
1923	1893.33
1924	2373.08
1925	3389.01
1926	4022.55
1927	5339.05
1928	6815.04

Respectfully submitted,

W. B. HERMS
R. W. DOANE
G. M. BENTLEY
E. N. CORY
C. W. COLLINS, *Chairman*

Voted that the report be accepted.

PRESIDENT W. B. HERMS: Next we will hear the report of the Committee on National Museums.

REPORT OF THE COMMITTEE ON NATIONAL MUSEUMS

Last year the Association adopted a resolution "that the scope of this Committee be extended so that consideration be given to the National Collection of Canada." Under the circumstances the old name of Committee on the U. S. National Museum is no longer appropriate. We have, therefore, taken the liberty of changing our name to the *Committee on National Museums*. We recommend that, in the future, Canada have representation on this Committee.

The National collection of insects of the United States and Canada are unique in that they are supported largely by the Agricultural departments of their respective governments. Because of this, both of these collections differ from other National collections in that they are developing the groups of economic importance and gathering together collections of the immature stages of insects.

This committee believes that cooperation between the Museums proper and the departments of Agriculture is mutually advantageous in building up collections of insects and providing adequate service to Agriculture.

The committee believes that the interest of this Association in the development of these collections is primarily to enable the economic entomologists to reap the benefits from such collections by making it possible for them to secure prompt and accurate identifications of materials submitted. To accomplish this purpose it is very desirable that additional specialists be secured to do taxonomic work and thus strengthen not only the service to economic entomology but at the same time build up stronger national collections.

The most practical way of obtaining the service required is by increasing the forces of specialists employed by the two departments of Agriculture.

The National Museums are urged to recognize the value to be gained in the formation of national collections by the development of taxonomic activities in the agricultural departments and do all in their power to provide adequate facilities and space for the specialists of these departments.

Respectfully submitted,

H. H. KNIGHT, Iowa
E. C. VAN DYKE, California
J. J. DAVIS, Indiana
R. W. HARNED, Mississippi
W. E. HINDS, Louisiana
Committee

Voted that the report be accepted and the recommendation adopted.

PRESIDENT W. B. HERMS: Next is the report of the Program Committee.

REPORT OF COMMITTEE ON PROGRAM

During the year just passed the members of your Committee have had frequent conferences and have given much earnest thought and consideration to the program situation. The various members of your Committee have also as opportunity permitted discussed the general situation with other members of the Association, in an

effort to obtain suggestions from the membership, hoping thereby to determine the general trend of thought of the Association. In practically every case it was specifically suggested that the members of the Association put their ideas in writing in a letter for the consideration of the Program Committee but the Committee is sorry to report that in practically no instance has this been done.

The Committee is of the general conclusion that the membership as a whole does not really want any radical change in the present Program arrangements. At the Nashville Meeting the Resolutions Committee brought in a recommendation to the Association that a summary of not more than 500 words be prepared for each paper on the Program and presented as an abstract at the Meeting instead of the present limitation of 5 minutes at the Meeting. The report of the Nashville Meeting, as published in the February 1928 issue, indicates that after considerable discussion it was the concensus of opinion that it was better to adhere to the present time limit of 5 minutes for each paper, allowing the author freedom to use the time in whatever way he considered best in presenting the subject. The membership voted that this resolution be laid on the table. This action convinces the Program Committee that the present arrangement as to time limited to each paper is in accordance with the wishes of the Association. This procedure has therefore been followed with reference to all papers presented at the general sessions of the Association for the present Meeting.

Your Committee recommends that the Association indicate its approval and encourage the formation of sections on specialized subjects, so that eventually it may be possible to provide opportunity for all papers to be presented by the membership that are offered, with reasonable time available for the presentation and for additional time for general discussion; it is believed that this end could be readily attained by providing for certain sectional programs to be run concurrently. The present arrangement providing for certain sectional programs, wherein the 5 minute limit is not applied on the sectional programs seems to be rather generally satisfactory and your Committee feels that the extension of the sectional idea would be a decided step in advance in the matter of Program improvement.

Your Committee further recommends that the Program Committee be discharged and that full responsibility be placed on the General Secretary for the arrangement of the General Program. If the first recommendation of the Committee is accepted and additional sections encouraged, it is believed that the General Secretary can readily handle the matter of the General Program with the Section Secretaries being responsible for arranging the various Sectional Programs and submitting them to the General Secretary who in turn can make all other necessary arrangements.

Respectfully submitted,

W. E. BRITTON
A. F. BURGESS
C. H. HADLEY, *Chairman*

Voted that the report be accepted and the recommendations adopted.

PRESIDENT W. B. HERMS: We will now listen to the report of the Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints.

REPORT OF COMMITTEE TO FORMULATE PLANS FOR INVESTIGATIONS OF THE CODLING MOTH FROM BIOLOGIC AND CONTROL STANDPOINTS

By vote of the Association this committee continued to function during the year 1928.

The committee met at Washington, D. C., January 2. This meeting was converted into a general conference, attended by a number of other entomologists who are interested in various phases of the codling moth problem. The results of the previous season's work were discussed, and plans were formulated for the coming season's work.

The minutes of this meeting, together with statements from several other entomologists, who were unable to attend, were circulated among the men who participated in the conference. These minutes have also been available to other entomologists interested in the problem.

In order to summarize the present season's developments an inquiry was addressed to some thirty-one investigators, of whom twenty-seven have responded. Replies were received from the following cooperators, the nature of the information supplied being briefly indicated:

ARKANSAS. A. J. Ackerman, U. S. Bureau of Entomology, Bentonville.

Residue situation; field tests of aluminum arsenate, zinc arsenate, oil sprays, nicotine, pyrethrum, derris.

COLORADO. G. M. List, W. P. Yetter, Jr., and J. H. Newton, Colorado Agricultural Experiment Station.

Residue situation; field tests of shortened schedules, nicotine, pyrethrum, and derris; banding; bait traps; parasite utilization.

CALIFORNIA. W. B. Herms and A. D. Borden, California Agricultural Experiment Station.

Residue situation; banding work; bait traps; lights as deterrents of oviposition, seasonal observations.

S. E. Flanders, Saticoy Walnut Growers' Association.

Treatment of infested drying trays; parasite records; mass rearing of *Trichogramma;* biological observations.

DELAWARE. H. L. Dozier, Delaware Agricultural Experiment Station.

Residue situation; fish-oil sticker, chemically treated bands.

GEORGIA. C. H. Alden, Georgia State Board of Entomology.

Residue situation; dusting experiments; banding work; utilization of *Trichogramma.*

ILLINOIS. W. P. Flint, Illinois State Natu al History Survey.

Residues; field tests of fluorine compounds, oil sprays, nicotine and derris; banding; bait traps; utilization of *Trichogramma.*

INDIANA. J. J. Davis, Purdue University.

Residue; field tests of oils and repellent sprays; banding; baits; mass rearing of *Trichogramma.*

B. A. Porter and R. F. Sazama, Bureau of Entomology, Vincennes.

Field tests of fluorine compounds, cuprous cyanide; nicotine, derris, pyrethrum, fish-oil sticker, coated lead, oil sprays; laboratory insecticide studies.

KANSAS. P. M. Gilmer, Bureau of Entomology, Wichita.

Residue; seasonal and biological notes; field tests of lead dosage, nicotine, pyrethrum, derris, oil sprays, fluorine compounds, non-lead arsenicals; banding.

MARYLAND. N. E. McIndoo, Bureau of Entomologv, Sligo.
Laboratory tests of possible repellents.

E. H. Siegler and Luther Brown.
Chemically treated bands; laboratory insecticide tests.

MICHIGAN. R. H. Pettit, Michigan Agricultural Experiment Station.
Residue; oil sprays; nicotine.

MISSOURI. L. Haseman, University of Missouri.
Residue; oil sprays, dusts; banding; seasonal observations.

NEBRASKA. M. H. Swenk, University of Nebraska.
Residue situation; field tests.

NEW HAMPSHIRE. W. C. O'Kane, University of New Hampshire.
Seasonal observations.

NEW JERSEY. T. J. Headlee, New Jersey Agricultural Experiment Station.
Residue; field tests of impregnated oils; treatment of worms in hibernating quarters.

E. R. Van Leeuwen and L. C. McAlister, Jr., Bureau of Entomology, Moorestown.
Field tests of lead dosage, derris, pyrethrum, nicotine, oil sprays, aluminum arsenate, coated lead, and fish-oil sticker; injury tests of calcium arsenate, zinc metaarsenite, cuprous cyanide, zinc arsenate, and fluorine compounds; laboratory tests of 250 possible insecticides.

NEW YORK. S. W. Harman, New York Agricultural Experiment Station.
Field tests of cryolite, zinc and aluminum arsenates, barium fluosilicate, oil spray, bands.

OHIO. C. R. Cutright and J. S. Houser, Ohio Agricultural Experiment Station.
Field tests of various arsenical and fungicide combinations; substitution of oils for some of the cover sprays; laboratory and field studies of manganese arsenate as a substitute for arsenate of lead; banding studies and studies in larval behavior under field conditions.

OREGON. Leroy Childs, Hood River.
Residue, influence of lime on residue removal; field tests of oil sprays, nicotine, dusts; chemically treated bands.

D. C. Mote, B. G. Thompson, R. K. Norris, and Henry Hartman, Oregon Agricultural Experiment Station.
Spray residue, influence of lime on removal; field tests of calcium arsenate, oil sprays, nicotine, pyrethrum, dusts; banding; bait traps; parasites; seasonal notes.

PENNSYLVANIA. H. N. Worthley, Pennsylvania State College.
Banding work; observations on diseases.

SOUTH CAROLINA. C. O. Eddy, Clemson College.
Banding; spray injury.

VIRGINIA. W. S. Hough, Winchester Research Laboratory.
Field tests of nicotine, calcium arsenate, barium fluosilicate, and cryolite; resistant strains of worms.

WASHINGTON. R. L. Webster and Anthony Spuler, Washington State College.
Field tests of oil sprays, nicotine, pyrethrum, dusts; bait traps.

E. J. Newcomer and M. A. Yothers, Bureau of Entomology, Yakima.
Spray residue; field tests of fluorine compounds, zinc and aluminum arsenates, cuprous cyanide, oils, nicotine, pyrethrum, derris; banding; bait traps; biological.

The Bureau of Chemistry and Soils of the United States Department of Agriculture has furnished valuable cooperation in making analyses of fruit and foliage, and in preparing a number of materials for tests. This organization has also made another valuable contribution in making a statistical analysis of the arsenic determination obtained from a long series of apples which were analyzed individually. This has resulted in much less variation in the results of this season's analyses.

The Bureau of Plant Industry of the United States Department of Agriculture has continued its study of the many problems involved in the removal of spray residue by washing.

Acknowledgment is also made at this point of the valuable cooperation of the General Chemical Company of New York City in supplying a number of the less readily available insecticides used in experimental work this season.

Spray Residue

Present Residue Status: The residue situation remains about as reported last year. Most of the fruit from arid western sections when adequately sprayed according to present practices shows residue several times .01 tolerance. Elsewhere, with the exception of a few limited areas where codling moth control is especially difficult, the residue was almost without exception below .02 grains of arsenic. per pound, and for the most part below .01.

Residue Removal: Residue removal practices show little change from a year ago. The acid wash continues to be in nearly universal use in the arid regions of the West, and is rapidly being perfected. Little difficulty is being experienced in getting the fruit below the .02 tolerance, but occasional lots run above .01 grains of arsenic per pound. Elsewhere residues have been removed chiefly by wiping, the amount present being at most only slightly in excess of .02. With the reduction in the tolerance to .01 certain sections of the Middle West and East may find it necessary to wash.

Childs and Mote and associates found that the addition of lime to the second brood sprays aided in residue removal by washing, and also reduced the amount of calyx injury following washing, due to arsenic. Mote and associates report that the use of lime in the rinse bath aids by neutralizing the acid, and also tends to prevent arsenic injury around the calyx end.

Newcomer reports that the addition of lime to the second brood sprays reduces the amount of arsenic present at harvest time.

Insecticide Control

Stomach Poisons

Non-Lead Arsenicals: Tests were made with three of the more promising non-lead arsenicals in an effort to get away from the objectionable lead base. While fairly good results were obtained with these materials under conditions of light infestation, they all failed to give satisfactory commercial control where it was necessary to control large numbers of late hatching worms.

Aluminum arsenate was reported by Gilmer as falling down badly; by Ackerman, Hough, Newcomer and Spuler as being three-fourths as effective as arsenate of lead, and by Harman, MacAlister and Porter as being practically as effective as arsenate of lead. Hough reported complete defoliation in early August, resulting in very small fruit.

Zinc arsenate was tested by Ackerman, Gilmer, Harman, Newcomer, McAlister and Porter and gave fairly good results, but severe foliage injury was reported by McAlister.

Calcium arsenate failed to control late worms according to Gilmer, and two preparations of calcium arsenate with sulphur were reported by McAlister as giving serious injury. Hough reported calcium arsenate as being nearly as effective as arsenate of lead, while Mote reported slightly better results with calcium arsenate than with arsenate of lead.

NON-ARSENICALS: Several fluorine compounds have been tested and found by most investigators to be unsuitable for codling moth control. The only exception to this occurred in the Northwest, where Newcomer obtained good results, suggesting that these materials may have possibilities under the arid conditions in that section.

Barium fluosilicate gave poor results in tests conducted by Flint, Gilmer, Harman, Hough and Porter, with injury reported by McAlister and Porter. In the Northwest, Newcomer found it to be nearly as effective as arsenate of lead.

Sodium fluosilicate was found by Flint to be much less effective than arsenate of lead.

Potassium fluosilicate was tested by Flint and Porter and found to be less effective than arsenate of lead, whereas Newcomer found it to be about equivalent to arsenate of lead. McAlister reports injury from the use of this material.

Cryolite was found unsatisfactory by Gilmer and Porter, fairly effective by Harman and Hough, and practically as effective as arsenate of lead by Newcomer. McAlister reports serious injury.

Cuprous cyanide gave good results in Newcomer's tests and fairly good results in Porter's. Gilmer and McAlister report serious injury.

ARSENATE OF LEAD

DOSAGE: In heavy infestations (Gilmer, List and Newcomer), the higher strengths of lead were more effective. In other tests (Ackerman, Flint, Porter and McAlister), the differences were not very wide because of the fact that arsenate of lead 1–50 was sufficient for practically complete control of the light infestations to be controlled.

FISH-OIL STICKER: This sticker was reported on favorably by Dozier, Gilmer, and Spuler. The differences appearing in tests conducted by McAlister and Porter were of little significance, owing to the lightness of infestation.

DUSTS: Unfavorable reports on the use of dusts were received from Alden, Childs, Flint, Spuler and List. Haseman reports two experiments in which dusts appeared inferior to liquid, and one in which satisfactory control was obtained. Mote reports good results from the use of dust. Headlee suggests the use of dusts in late applications to reduce the amount of residue.

CONTACT MATERIALS

The experiments reported show that the contact materials have possibilities for development to the point where they may have a place in the control program. The most encouraging results were obtained with combinations of oil sprays with other contact materials. Adaptations of some sort are needed, since none of the ordinary contact materials have given satisfactory results when used as ordinarily employed against other insects.

NICOTINE: Spuler reports that tests of various combinations, in which three concentrations of two types of oil were used, with three concentrations of nicotine sulphate, gave uniformly good worm control. Flint and Mote and associates report similar favorable results with nicotine-oil combinations.

In other tests, in which nicotine was used chiefly as ordinarily employed (Ackerman, Gilmer, List, Newcomer, McAlister, and Spuler) nicotine showed comparatively little value. Some increase in the effectiveness of nicotine resulted from the addition of aluminium sulphate (Newcomer, Mote, Spuler) but Spuler reports russeting of the fruit.

PYRETHRUM: Headlee reports that a white oil impregnated with pyrethrum is very effective. Repeated applications during June, however, dropped 50 per cent of the fruit and foliage. Applications made after July 1 caused no injury.

Commercial pyrethrum material made according to the Japanese beetle formula at one per cent gave only slight control in tests conducted by Ackerman and Gilmer. A kerosene extract appeared practically useless in a test conducted by Newcomer, and of little value in a test conducted by McAlister. List reports that Evergreen, a commercial extract used in a large block at Grand Junction, Colo., proved of no value, while Mote reports fair results, and Spuler reports that the same material used with arsenate of lead ½ to 50 gave results the same as those obtained with arsenate of lead 1 to 50 alone.

DERRIS: Flint reports good results with commercial derris extract combined with white oil 1–¼ per cent.

An alcoholic extract of derris used against second brood worms appeared to be of little value (Ackerman, Gilmer, Newcomer, McAlister).

OIL SPRAYS: Oil sprays alone gave comparatively poor results in tests conducted by Davis, Gilmer, Haseman, and Spuler; fair results in tests conducted by Ackerman, Flint, Harman, Mote, Newcomer, and McAlister. Childs reports that the use of oil in any cover applications results in some calyx burn to Newtowns, and Mote reports similar injury. Ackerman reports severe injury following two applications of white oil at 2%. Herms and Borden report that high viscosity oils cause injury to fruit, either in size or marking, and that applications made during 1928 under temperatures of 100° in June caused heavy leaf and fruit drop. Newcomer reported that oils of 50 viscosity caused no injury, whereas oils of 100 viscosity dropped quite a few leaves.

The combination of an oil spray with arsenate of lead has for the most part given good control (Childs, Flint, Harman, Spuler), although poor results were reported by List. Pettit states that the combination is a trace better than arsenate of lead alone, but not enough so to be worth the additional cost. Spuler varied the amount of arsenate of lead and found the control to be proportional to the amount of lead. Mote and associates report that the combination did not reduce the amount of residue, and that it greatly lowered the efficiency of washing.

Certain impregnated oils appear promising (Davis, Flint).

REPELLENTS

Davis reported favorable indications from small field tests of repellent sprays, and McIndoo reports preliminary laboratory tests of possible repellents.

CONTROL BY MEANS OTHER THAN SPRAYING

Banding

BANDING MATERIALS: The statements regarding the most satisfactory materials for use in banding are too conflicting to warrant definite conclusions.

CHEMICALLY TREATED BANDS: The reports on chemically treated bands apply almost entirely to the beta-naphthol bands, treated as suggested by Siegler and his

associates. The results are very conflicting, but the favorable reports from tests conducted under conditions of heavy infestation are extremely encouraging. Practically no emergence was reported from tests conducted by Alden, List, Mote, Siegler and Yothers. Poor results were reported by Worthley, while Childs and Dozier are suspending judgment. Practically all investigators report large numbers of living larvae in the bands examined after harvest, which is to be expected. The bands are not likely to be effective over two seasons, and these living larvae would normally be destroyed in removing the bands during the winter season.

Most investigators (Alden, Gilmer, Harman, Haseman, List, Mote, Siegler and Yothers) report that no repellent effect was evident. In fact, several reports showed a larger number of worms under the treated bands than under the untreated. Davis Flint, and Spuler however, found indications that the chemical was repelling the worms. Injury to the outer layers of bark was noted by Alden, Eddy, Yothers and Haseman. Among the materials other than beta-naphthol, Davis reports favorably on Alpha-naphthylamine, and Flint on Mono-chloronaphthalene and orthotoluidene.

BAIT TRAPS: In the Northwest, List, Spuler and Yothers report favorable catches of moths and believe that bait traps are of value as an accessory measure. Mote mentions favorable reports from growers. Elsewhere, (Flint, Davis, Harman, Headlee, Herms and Swenk) the results have been less favorable, and the traps are considered of value chiefly as indicators of the presence of moths in the orchard.

TREATMENT OF WORMS AND HIBERNATION: Headlee reports a complete kill of worms hibernating on tree trunks as the result of spraying the trunks of the trees with a miscible pine oil, no injury to the trees resulting. In connection with this, he has found that in cultivated orchards 91 per cent of the overwintering generation of moths come from the rough bark portions of the trees, 9% from the tops, and none from the ground.

UTILIZATION OF PARASITES: For the most part the past season's efforts have been toward overcoming certain difficulties in the rearing technique (Davis, Flint and List). Flanders reports various details regarding his technique and states that practical commercial use of parasites has yet to be demonstrated. Alden liberated 40,000 *Trichogramma* and later found 96 per cent of the eggs parasitized. He believes that the utilization of parasites has commercial possibilities in Georgia.

BIOLOGICAL

Hough reports that last season's work has been corroborated by the studies made this season and states that his work has demonstrated three points: (1) that strains differ in their ability to penetrate a covering of arsenate of lead; (2), that this quality is hereditary; (3) that crosses are intermediate between the parent strains.

Newcomer reports that worms from Washington have a slightly greater ability to penetrate arsenate of lead than those from Virginia.

Herms and Borden report that lights in the orchard in early evening appear to reduce the number of eggs laid.

A. L. QUAINTANCE, *Chairman*
GEORGE A. DEAN
W. P. FLINT
P. J. PARROTT
B. A. PORTER
LEROY CHILDS

Presented for the Committee by B. A. Porter.

Voted that the report be accepted.

PRESIDENT W. B. HERMS: Next is the report of the Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer.

REPORT OF THE JOINT COMMITTEE ON THE EUROPEAN CORN BORER

Appointed by

THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
THE AMERICAN SOCIETY OF AGRONOMY
THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
AND THE AMERICAN FARM ECONOMIC ASSOCIATION

The European corn borer, which was first discovered in New England in the summer of 1917, has continued its natural spread until at the present time (September, 1928) the insect occurs throughout more than 230,000 square miles of territory in North America, including the whole or parts of the northeastern states; and New York, Pennsylvania, West Virginia, Ohio, Michigan and Indiana; and parts of the provinces of Ontario and Quebec, Canada. Vigorous measures have been taken to prevent long-distance spread by artificial means. This effort has been successful. The only known spread of any importance in the United States, therefore, has been by the natural flight of the corn-borer moths or by waterdrift of infested material. This spread has been at an average rate of from 20 to 30 miles per year. From any information now available there appears to be no practicable means of preventing this natural spread.

The results of the extensive studies of the borer in this country and in Central Europe furnish convincing evidence that the insect is of tremendous potentiality and ranks as one of the most alarming crop pests ever introduced. The situation, presenting, as it does, the possibility of a national calamity, calls for the continued cooperation of the farmer, the scientist, the educator, and all state and federal administrative officials.

The intensity of infestation by the corn borer in the western area has increased steadily since its discovery there in 1920. Before clean-up practices were applied in Kent and Essex Counties, Ontario, severe commercial damage was suffered, and this resulted in a large reduction of corn acreage. Since clean-up practices have been applied in that district, there has been a decrease in the intensity of infestation and an increase in acreage. This is a hopeful indication of the effectiveness of control measures and the possibility of continued corn production under conditions thought to be most favorable to the borer.

The cooperating committee of entomologists, agronomists, agricultural engineers, and agricultural economists wishes to indorse most heartily all efforts to control the corn borer, and to commend all persons engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the fullest development of the research, educational, and quarantine programs of the State and Federal Governments and earnestly recommends the appropriation of the funds necessary to maintain and expand these activities. However, the committee does not favor a large Federal appropriation for a compulsory clean-up campaign for the following reasons: (1) The break in the continuity of the clean-up program in 1928 due to the failure of the

appropriation for this purpose; (2) the impossibility of securing an appropriation in time for an effective clean-up to protect the crop of 1929; (3) the impracticability of enforcing effective clean-up under present state laws.

After careful and complete investigation of the corn-borer regulatory, research, and educational activities, the committee suggests and recommends:—

1. That the State and Provincial Agricultural Experiment Stations, and State Departments of Agriculture, and all other agencies interested in the welfare of American agriculture, give their support and encouragement to the Federal Governments of the United States and Canada in their policies on quarantine activities. Scouting should be continued in the areas contiguous to known infested areas and extended to the large corn-producing States where areas seem particularly exposed to infestation. Ample Federal funds should be available for a thorough clean-up of isolated infestations.

2. That major efforts in corn borer research, control, and educational activities be directed toward making possible the maintenance of our present corn acreage, in view of the economic importance of corn and the present advantages which this crop holds over any alternative crop as a revenue producer in the corn belt, and the certainty that farm incomes will be greatly reduced unless this is accomplished.

3. That the corn breeding program to produce strains that may be resistant or tolerant to the corn borer, or which may escape attack, should be continued.

4. That soil and cultural practices that may avoid reduction in yield and quality of corn by the corn borer, such as time, rate, and method of planting, soil fertility treatments, and retardation studies, should be investigated further.

5. That studies should be continued on the physiology and morphology of the corn borer and its hosts, especially the corn plant, in relation to infestation, establishment, and damage and to the yield of corn.

6. That there be continued on many fields distributed over the area of heavy infestation, the study of the relation of corn borer infestation to time of planting, variety, soil type, height at the peak of moth flight, earliness of maturity and yield of corn.

7. That the study of the ecology of the corn plant be extended to the entire Corn Belt and that similar studies of the corn borer be extended as the spread of the insect permits.

8. That experiments on the long-time effect of various clean-up practices on soil productivity be continued.

9. That attention be given to studies of the possible substitution of other profitable crops for part of the corn in the rotation in those sections where the corn borer promises to become a destructive pest. Such studies shall include specifically the present and probable future market outlook for these substitute crops.

10. That studies should be made on reduction in yield or increased cost of crops other than corn, through changed methods as a result of the advent of the corn borer.

11. That efforts to determine the reduction in yield and quality of corn resulting from different densities of borer population, should be continued and enlarged to include determinations of such damage at different degrees of soil productivity. Such information is essential to reliable recommendations as to varieties, cultural practices, and possible substitute crops for corn, as well as to determine the clean-up practices that will be profitable.

12. That detailed cost-account work should be done, both within and outside of the infested areas, for the purpose of determining the costs of different farm oper-

ations, to serve as a basis for recommending changes in practices if they should become necessary.

13. That the important projects now under way to introduce and establish parasites of the corn borer from foreign countries, be continued and enlarged. It also is recommended that all such initial introductions of parasites, predators, entomophthorous fungi and bacterial diseases from foreign countries be entirely under the direction and supervision of the United States Department of Agriculture or the Department of Agriculture for Canada.

14. That continued studies should be made of the habits, life history, and envionmental influences affecting the spread of the corn borer and intensity of infestations, also upon the limitations of corn as to its seasonal, varietal and cultural practices. Such information is essential to combating the corn borer and will assist the entomologists, agronomists and engineers in the development of controls.

15. That the experiments and demonstrations to determine the value of plowing under corn residues as a means of destroying the corn borer should be continued. These studies should include a determination of the comparative value of fall and spring plowing in different types of soil, with different widths and types of bottoms, on different dates, and at various depths.

16. That the experiments in the large screened areas should be continued to determine the relative degrees of infestation and damage to be expected, (a) where no effort at clean-up is made and (b) where the most practical clean-up methods are employed.

17. That investigations upon insecticides, repellents and attrahents be continued.

18. That in one-generation areas the study of weeds and plants other than corn be continued to determine what part these may play in the future as breeding hosts of the borer, especially in districts where, owing to the severity of the infestation, corn growing may be reduced temporarily.

19. That in view of the interdependence of machinery requirements and design, intensive development work should be continued. The experimental and research programs should be correlated with control methods and large-scale field procedure.

20. That the control of the corn borer by mechanical means is of demonstrated importance and undoubtedly will continue to be so as long as the pest remains a menace to the corn crop of the country and therefore comprehensive and vigorous research programs relating to mechanical operations of crop production and commercial utilization should be continued by state and federal agencies.

21. That we indorse the machinery development program which is being conducted by state and federal agencies along crop production and utilization lines. Since no one method or machine is adapted to all conditions, it is recommended that more complete information be made available in regard to cost and effectiveness of using rakes, burners and other stalk and remnant disposal machinery and other devices to supplant hand labor.

22. That studies be made to determine the effects on farm incomes of different methods of harvesting and utilizing corn stalks, both commercially and on the farm.

23. That radical changes in agricultural practices should be recommended only if justified by the results of economic surveys including farm cost records.

24. That the State and Federal extension agencies take every opportunity by demonstrations, exhibits and lectures to acquaint their constituencies with the gravity of the corn-borer problem, the nature of the insect and its work, and the methods of

meeting the situation. The need of the cooperation of every grower in the regions adjacent to the infested area as well as within recognized corn-borer territory should be emphasized.

25. That Federal and State administrative authorities be urged to make available at frequent intervals up-to-date information regarding the general situation and the progress of infestations in the United States, Canada, and abroad, through the medium of bulletins, circulars and leaflets. Also, where advisable, mimeographed statements of progress be issued at frequent intervals to technical workers.

26. That the committee act as a clearing house in advancing corn borer measures by obtaining opinions from the entomologists, agronomists, agricultural engineers, agricultural economists and others, as to the lines of research and other methods which should be pursued, with special reference to needed investigations not now under way and which may have a practical application to the problems.

27. That the fullest program of research be conducted along all lines offering promises of assistance and the fullest financial support for such research programs be provided, research being recognized as the basis of all progress in methods of control of the corn borer.

28. It is recommended that copies of all written reports or recommendations of the committee be made available to the Secretary of the United States Department of Agriculture and the Minister of Agriculture for Canada.

Respectfully submitted,

G. A. DEAN
L. CAESAR
D. J. CAFFREY
C. J. DRAKE
J. J. DAVIS
For the Entomologists

L. E. CALL
W. L. BURLISON
J. F. COX
R. M. SALTER
F. D. RICHEY
For the Agronomists

C. O. REED
A. L. YOUNG
R. B. GRAY
R. D. BARDEN
WILEMAN
For the Agricultural Engineers

C. R. ARNOLD
H. C. M. CASE
O. G. LLOYD
C. L. HOLMES
H. R. TOLLEY
For the Agricultural Economists

There was some favorable discussion with reference to details of the report which were explained by Chairman Dean.

Voted that the report be adopted.

PRESIDENT W. B. HERMS: Next is the report of the Committee on Insect Pest Survey.

REPORT OF THE COMMITTEE ON THE INSECT PEST SURVEY

We view, with satisfaction, the fact that the Insect Pest Survey has been placed on a project basis with a definite appropriation and that arrangements have been made to increase the staff materially. The activities of the Survey can now be extended into new and useful fields and will be of increasing value to all workers in Economic Entomology.

We urge all workers in this field to continue their hearty cooperation with the Survey.

We feel that this committee has served its purpose and respectfully request that it be discontinued.

(Signed) LEE STRONG
C. R. CROSBY

Committee

Voted that the report be adopted.

PRESIDENT W. B. HERMS: Now we will listen to the report of the Committee on Recommendations to Secretary of Agriculture with Reference to Needs for Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or Likely to be Introduced.

REPORT OF THE COMMITTEE ON THE INVESTIGATION OF FOREIGN PESTS

With the development of country-wide agencies for determining the losses suffered in agriculture from insects and diseases, has come a consciousness of the tremendous tax that this industry and with it the rest of the nation must bear to make up for the damage done by our multitude of crop parasites. It has been conservatively estimated that our plant products are depleted to the amount of 25% annually by the inroads of insects and diseases, and it is most significant that by far the greater part of this tax on our national economy must be attributed to pests of foreign origin (See Appendix I). A decade or more ago the hope was cherished that by means of a quarantine system sufficiently broad in scope and effectively administered, the host of invaders still waiting to reach our continent might be kept out with a completeness that would enable us to develop our agriculture on a permanent and stable basis. But along with the rapid advancement in transportation methods, and large and constant increase in world wide travel and traffic together with the demand for foreign goods brought about by a higher general standard of living, the rising flood of materials from abroad has swelled to a point where the quarantine dam, however well constructed, seems insufficient to protect the country indefinitely from further invasion. Your committee feels that it is voicing a widespread conviction in expressing the opinion that permanent exclusion of foreign pests can scarcely be regarded as attainable and that sooner or later foreign insects and fungi are likely to be spread as far as food, climate and natural enemies will permit.

This belief does not by any means imply that an open door policy should be established. It is decidedly to our advantage to delay all unwelcome immigrants as long as possible, not only because each imported parasite lessens in a permanent way the productive capacity of the nation, but also because each intruder disturbs the balance of agriculture, whereupon constant and costly readjustments must be made in the industry perhaps the least adaptable of all to sudden change.

But while all quarantine effort should be maintained or even strengthened it may be expected that from time to time some of the dangerous parasites from other parts of the world will slip past the line of guard and establish themselves in our midst. With the danger of such leakage constantly before us it would seem obvious that the foresighted and profitable thing to do would be to study these prospective pests in their place of origin; an intimate knowledge of habits, life histories, means of

dissemination and methods of control might not only enable us to guard against, or at least delay, their introduction here, but if they should finally enter this country there will be at once available a body of knowledge which would enable us to cope with them immediately instead of devoting precious years to devising ways and means of control. Surely in a matter involving the basic food supply of our rapidly increasing population we may rely on the far-visioned interest of our national leadership to take these simple precautions for safeguarding its future.

Your committee notes that the necessity for investigation of this kind has already been recognized by the Federal authorities at Washington and that on several occasions studies of foreign parasites not yet introduced here have been undertaken by them (See Appendix II). It is urged that steps be taken to formulate and put into effect a definite, permanent and adequate program for the purpose of making such studies.

Your committee further suggests that while colleges and private research institutions should be encouraged as far as possible in making contributions to our knowledge of foreign pests and their control, yet it would appear that leadership in this field ought to rest with the Federal government, since it has above all other agencies a wide experience, a deep understanding of the subject from many angles, and can most readily command both staff and financial support on a large enough scale to make the program effective. Moreover in matters of this nature arrangements with foreign governments are concerned and the Federal authorities are in a better position to deal with such relations than private institutions.

Your committee further recommends that this society bring these considerations to the attention of the proper Federal authorities with an earnest request, first, that adequate provision be made for the investigation of insects and diseases in their native habitats which because of geographical, crop, or commercial conditions are likely to be introduced here; second, that such investigations shall include the collection of all information relating to these insects and diseases which might enable us to prevent or delay their entry here or in case of their accidental introduction at least to provide effective and immediate control; third, that in conformity with this policy steps be taken to carry out such investigations on the following:

Respectfully submitted,

P. J. PARROTT
W. J. SCHOENE
T. J. HEADLEE
J. E. GRAF (*Consultant*)

Committee in cooperation with the American Phytopathological Society.

APPENDIX I

Some idea of the present situation in regard to a few of the insects and diseases introduced to this continent in former years is here presented. It is apparent that with few exceptions spread from the area where establishment first took place could not be prevented and that in nearly all cases many years have elapsed before adjustment took place or satisfactory control was worked out. This list is merely illustrative and could be extended to great length. The importance of these problems to the country is indicated by the sums already expended in quarantine or control efforts.

INTRODUCED INSECT PESTS

Insect	Time of Introduction	Funds Expended to date	Present status of control
European Corn Borer	About 1916?	$20,000,000.00?	Biol. control uncertain, partial field control by clean-up methods
Japanese Beetle	About 1916	$ 2,000,000.00	Biol. control promising but not yet effective. Spraying and nursery inspection fairly successful.
Gypsy Moth	1868 or 1869	$28,000,000.00	Spraying effective. Biological control promising.
Oriental Fruit Moth	About 1916	$ 43,450.00	No practical control methods yet known.
Mexican Bean Beetle	About 1920 (in East)	$250,000.00	Spraying fairly satisfactory.

INTRODUCED PLANT DISEASES

Disease	Time of Introduction	Funds Expended to date	Present status of control
White Pine Blister Rust	About 1903		Basis of present satisfactory control established 1918.
Potato Wart	About 1912		Immune varieties as in Europe since 1922 satisfactory for most of potato growing area.
Chestnut Blight	About 1900–06		None to date. Looking for resistant species.
Poplar Canker	About 1916		None to date. Poplars being replaced by other species.
Sugar Cane Mosaic	Prior to 1913		Now looking for resistant varieties.
Larch Canker	1926		No control measures yet known.

APPENDIX II

There are listed below some of the cases in which studies of insects and diseases in foreign lands have already been made by this country in an effort to obtain information which would be of value in solving their control here. It is worthy of note that with two (?) exceptions these investigations were conducted *after* the pests concerned had established themselves in this country and *not before* they reached here. The exceptions mentioned concern the downy mildew of corn and larch canker.

In 1919 J. G. Sanders visited Great Britain on behalf of the Federal Government

to study conditions there in regard to the spread, damage and control of the potato wart disease, already introduced to this country from Europe.

Dr. Perley Spaulding spent some time in northern Europe in 1922 making observations on the white pine blister rust situation. In 1919–20 W. S. Moir was sent to Europe to study this same disease.

The downy mildew disease of corn as yet unknown here was studied in the Phillipines by W. H. Weston.

R. K. Beattie is now in Japan on a search for blight resistant chestnuts.

A similar search is now under way in the Dutch East Indies where Brandes is looking for sugar cane resistant to mosaic.

Studies of the larch canker problem are now under way for two years in Scotland where Glenn Hahn of the Office of Forest Pathology is investigating this disease in its native home.

Appendix III

Your committee hesitates to present any detailed plan for the further organization of this program, having in mind that these matters are closely bound up with budgetary and administrative limitations and procedure. But it desires to present the following suggestions as to features in this program which ought to be given due consideration:

1. The type of investigations herein urged should be carried out primarily on a rather definite crop or project basis, rather than as an attempt to collect general information over the whole range of pests in other parts of the world.
2. At the outset attention should be centered on those localities which because of trade volume, presence of known pests, or other considerations may be considered as danger points.
3. Such investigations should cover host range, nature and extent of damage, life history data, biological and artificial control, methods, means and materials by which the parasite might be brought to this country and such other features as might have a bearing on exclusion in the first place or control in case of accidental introduction.
4. Problems which are considered of such importance as to warrant immediate consideration are as follows:
   Citrus Black Fly (Plans now underway to obtain parasites from India and Sumatra in cooperation with Cuba).
   Oriental Fruit Moth (Parasitic work soon to be undertaken).
   Fruit Flies (Principally Mediterranean and tropical America).
   Mexican Bean Beetle (Plans being considered to undertake studies in Mexico to determine relations between host and parasites).

Voted that the report be accepted and the recommendations adopted.

President W. B. Herms: Next we will listen to the report of the Committee on Training of Entomologists.

REPORT OF COMMITTEE ON THE TRAINING OF ENTOMOLOGISTS

At the Nashville meeting a resolution was adopted by the Association providing for the appointment of a committee which should study the problem of the training of an entomologist. The committee was duly appointed and after some unavoid-

able delay was organized. The report here presented is preliminary only, since the committee considers that its task is one that will require a long period of time, many consultations with members of this Association, much discussion among its own members, and a long and deliberate study.

The committee takes its task seriously, but it wishes to make clear that it has no thought of setting up an inflexible curriculum for the training of an entomologist, or proposing arbitrary procedures. It hopes rather to be the means of securing exchange of views among members of the Association and of crystallizing ideals.

For the purpose of clarifying its own aims and defining various aspects of entomological training, the committee has attempted to sub-divide entomological training as follows:

(1) Professional training, consisting of four years undergraduate work.

This may be considered as qualifying men to fill such positions as that of plant quarantine inspector, technical assistant, extension assistant, nursery inspector, assistant in control projects, routine worker in commercial enterprises, demonstrator for commercial enterprises.

(2) Advanced professional training, including four years of undergraduate work and three years of graduate work.

This, in turn, may be considered as falling into two divisions, as follows:

(a)—Descriptive. Under this may be included the training of such specialists as the taxonomist, the morphologist, the anatomist.

(b)—Experimental. Under this falls the training of such specialists as the parasitologist and medical entomologist, the specialist in biological control, the specialist in the role of insects as carriers of plant diseases, the ecologist, the toxicologist or insecticide specialist, the physiologist.

With this preliminary differentiation before it, the committee now purposes to seek the counsel of various members of the Association, and to see what it can do in the way of setting up suggestive curricula for study and discussion.

Respectfully submitted,

W. A. RILEY
A. C. BAKER
C. J. DRAKE
H. J. QUAYLE
W. C. O'KANE

Committee

Voted that the report be accepted and the work of the committee continued.

PRESIDENT W. B. HERMS: I will now appoint several committees.

Nominating Committee: J. S. Houser, Arthur Gibson and B. A. Porter.

Resolutions Committee: E. O. ESSIG, C. R. CROSBY and C. J. DRAKE.

The Nominating Committee will take into account the amendment to the Constitution which was adopted at this meeting concerning the Executive Committee.

VICE-PRESIDENT P. J. PARROT assumed the Chair.

VICE-PRESIDENT P. J. PARROTT: President Herms calls my attention to the fact that there are two more items of business that need to be considered, one under the category of miscellaneous business. Is there anything to be considered under that item? If not, we will pass to the next. Is there anything to be considered under the item of new business?

(At this point the annual address of the President was delivered which appears in Part II).

FINAL BUSINESS

The final business was transacted Monday morning, December 31st.

The meeting convened at 9:45 with President W. B. Herms in the Chair.

PRESIDENT W. B. HERMS: The first committee report this morning is that of Resolutions.

REPORT OF THE RESOLUTIONS COMMITTEE

RESOLVED: That we extend to our secretary, C. W. Collins, a vote of thanks and appreciation for his continued efficient services.

RESOLVED: That, a vote of thanks be extended to the local committee: Messrs. Moore, Lutz, Felt, Davis, and Weiss for the great amount of work done to insure the success of our meetings and the comfort and enjoyment of our members.

RESOLVED: That, we compliment our retiring president, W. B. Herms, upon his splendid annual presidential address.

RESOLVED: That, in order to promote closer relationships with the Entomological Society of America, that a permanent coordinating committee, consisting of two members and the secretary, be appointed to assist in bringing about a closer affiliation in the programs and such other matters as may be deemed necessary. This resolution has been proposed as the result of the creation of a similar committee by the Entomological Society of America.

RESOLVED: That, we convey by telegram our best wishes, to Professor and Mrs. J. H. Comstock.

RESOLVED: That, in view of his 19 years of service as Associate Editor of the JOURNAL OF ECONOMIC ENTOMOLOGY, we extend to Dr. W. E. Britton a vote of thanks and appreciation upon his retirement at this time.

RESOLVED: That, Inasmuch as the gipsy moth is recognized as one of the greatest menaces to forest and shade trees and that the density of infestation during the last few years has steadily increased in the territory east of the Connecticut River and in many towns immediately bordering the "Barrier Zone" and involving further westward spread of the insect, we recommend that the Federal funds should be made available to furnish adequate protection to the "ZONE" and that all states lend their support to the end that further spread of the insect may be prevented.

RESOLVED: That the Western Plant Quarantine Board, at its 10th Annual Conference in Salem, Oregon, July 12–14, 1928, does heartily approve the movement looking toward more extensive study of foreign pests and diseases in the countries where they are now prevalent: and directs the transmission of a copy of this resolution, as an indication of its support, to the committees recently appointed by the

American Phytopathological Society and the American Association of Economic Entomologists to promote jointly such important work.

C. R. CROSBY
C. J. DRAKE
E. O. ESSIG, *Chairman*

Voted that the report be accepted and the resolutions adopted.

PRESIDENT W. B. HERMS: Next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

Your Committee begs to submit for your approval the following report on its activities during the past year and recommends that the following five candidates be elected to Foreign membership.

Parker, Theodore, Leeds University, Leeds, England.
Trouvelot, Bernard, Inst. Agri. Research, Paris, Fr.
Ruzkowski, J. W., Solacka, Poznau, Poland.
Scaramuzza, L. C., Camaguey, Cuba.
Filipjev, T. N., Gertzena 44, Leningrade, Russia.

The committee further recommends the reinstatement to Associate membership of the following five named candidates.

Gill, J. B.	Blanchard, R. A.
Armitage, H. B.	Yothers, M. A.
Chapman, J. W.	

The Committee further recommends that the following forty-eight Associate members be advanced to Active membership:

Armstrong, Thomas	Gui, H. L.	Parker, R. L.
Arnold, T. A.	Guyton, F. E.	Potts, S. F.
Baird, A. B.	Haber, V. R.	Price, W. A.
Bartley, H. N.	Haley, W. E.	Roark, R. C.
Berley, J. A.	Hamner, A. L.	Robinson, William
Burdette, R. C.	Harman, S. W.	Rude, C. S.
Campbell, F. L.	Ingram, J. W.	Schlosburg, M.
Cecil, R.	Jones, M. P.	Stene, A.
Dampf, Alfons	Knowlton, G. F.	St. George, R. A.
Driggers, B. F.	Lauderdale, J. L.	Stone,W. E.
Dunivan, David	Lawson, P. B.	Thomas, C. A.
Dustan, A. G.	McBride, O. C.	Tissot, A. N.
Flanders, S. E.	McKinney, K. B.	Todd, F. E.
Fleury, A. C.	Miller, R. L.	Vansell, G. H.
Gambrill, F. L.	Milum, V. G.	Weed, Alfred
Griswold, Grace	Munro, J. A.	Wilcox, J.

The Committee further recommends that the following one hundred two candidates be elected to Association membership:

Allen, W. L.	Barnes, J. W.	Berry, P. A.
Arant, F S.	Barnes, O. L.	Bieberdorf, G. A.
Avery, P. C.	Baumgartner, M. H.	Becton, E. M.
Baker, F. E.	Barrett, R. E.	Brunson, M.

Brindley, T. A.
Cavitt, H. S.
Clarke, C. A.
Clarke, W. H.
Coffin, O. T.
Coleman, Wallace
Conklin, J. G.
Couch, O. E.
Crane, H. A.
Crooks, C. A.
Curl, L. F.
Davis, A. C.
Deay, Howard
Dearborn, F. E.
Diamond, V. R.
Duggan, C. E.
Douglas, W. A.
Douglass, N. L.
Dunham, W. E.
Drumheller, C. E.
Eaton, E. D.
Eaton, N. A.
Farleman, M. G.
Ford, M. H.
Fox, D. E.
French, G. T.
Franke, L. J.
Freeman, W. H.
Frost, L. A.
Gahm, O. E.
Gay, J. C., Jr.
Gersdorf, W. A.
Getzendaner, C. W.
Gould, George
Gray, H. E.
Harris, F. H.
Henneberry, T. V.
Holloway, J. K.
Henderson, C. F.
Hunt, R. W.
Hutchison, R. M.
Johnston, H. G.
Jones, L. G.
Jones, R. M.
Kennedy, R. D.
Kinsley, C. H.
Knight, Paul
Koch, K. L.
Lamiman, J. F.
Landon, W. E.
Latta, Randall T.
Light, S. F.
Lopez, A. W.
Marsh, H. L.
Maier, E. E.
Mechling, E. A.
Miller, D. F.
Montgomery, B. E.
Moody, D. L.
McConnel, H. S.
McGarr, R. L.
Page, G. N.
Parish, H. E.
Plummer, C. C.
Rawlings, R. T.
de Rekowski, C. W.
Robinson, R. H.
Rothe, C. H.
Schmidt, C. T.
Schwardt, H. H.
Singleton, J. M.
Shropshire, L. H.
Sheffield, S. S.
Shull, W. E.
Smith, R. G.
Smith, L. M.
Smith, S. D.
Spear, G. T.
Tenhet, J. N.
Tinkham, E. R.
Tischler, Nathaniel
Townsend, J. F.
Watts, H. R.
Werner, W. H. R.
Williams, L. L.
Wisecup, C. B.
Wray, D. L., Jr.
Wright, P. F.
Yetter, W. P., Jr.
Young, H. D.

The Committee further recommends that the resignations of the following members be accepted:

ACTIVE

Hopkins, A. D.

ASSOCIATE

Atkinson, N. J.
Baldwin, R. S.
Carpenter, C. F. G.
Hofer, George
Needham, P. R.
Pierstorff, A. L.

(Signed) J. A. Hyslop, *Chairman*
D. M. De Long
H. F. Dietz
Committee

Voted that the report be accepted.

President W. B. Herms: In the absence of the other members of the Advisory Committee of the Journal, I wish to nominate for the committee, the following officers: For Editor, E. P. Felt; Associate Editor, Dwight M. DeLong; Business Manager, C. W. Collins.

Voted that the report be accepted and the officers named elected.

PRESIDENT W. B. HERMS: Before calling for the report of the Committee on Nominations, may I take this opportunity at the close of my term of office to thank the members of the Association, and particularly the Chairmen of Committees for the fine cooperation accorded the Chair during the course of these meetings and indeed throughout the entire year. This has been a year of apparent harmony and good feeling among our members. I believe the Association is in a thoroughly sound condition. It has been pleasant to serve as President of the American Association of Economic Entomologists and the honor has been very much appreciated.

May we now have the report of the Committee on Nominations?

REPORT OF COMMITTEE ON NOMINATIONS

President: T. J. Headlee.
First Vice-President: E. R. Sasscer.
Vice-President (Pacific Slope Branch): O. H. Swezey.
Vice-President (Cotton States Branch): F. L. Thomas.
Vice-President (Eastern States Branch): E. N. Cory.
Vice-President (Section of Plant Quarantine and Inspection): F. N. Wallace.
Vice-President (Section of Apiculture): G. M. Bentley.
Vice-President (Section of Extension): J. A. Hyslop.

STANDING COMMITTEES

Executive Committee:
T. J. Headlee, ex-officio
R. W. Harned, term expires 1929
W. B. Herms, term expires 1930
C. W. Collins, ex-officio
L. S. McLaine, term expires 1929
W. P. Flint, term expires 1930
P. J. Parrott, term expires 1931

Membership Committee:
S. W. Bilsing, term expires 1931.

Advisory Board, JOURNAL OF ECONOMIC ENTOMOLOGY:
W. H. Larrimer, term expires 1931.
H. J. Quayle, term expires 1931.

National Museums:
A. W. Baker, term expires 1931.

Committee on Research Work in the Control of the European Corn Borer:
G. A. Dean, Chairman, term expires 1933
Lawson Caesar, term expires 1931
J. J. Davis, term expires 1930
C. J. Drake, term expires 1929
D. J. Caffrey, term expires 1932

Committee on Research Work to control the Codling Moth:
A. L. Quaintance, Chairman, term expires 1931
B. A. Porter, term expires 1931
G. A. Dean, term expires 1930
Leroy Childs, term expires 1930
P. J. Parrott, term expires 1929
W. P. Flint, term expires 1929

Board of Trustees for Permanent Fund:

C. W. Collings, ex-officio
T. J. Headlee, ex-officio
G. M. Bentley, term expires 1929
R. W. Doane, term expires 1930
A. F. Burgess, term expires 1931

Representative to National Research Council:

J. E. Graf (Alternate), term expires June 30, 1931.

Councillors for the American Association for the Advancement of Science:

Arthur Gibson
Franklin Sherman

Trustees for the Crop Protection Institute:

P. J. Parrott, term expires 1931

The Committee to Co-operate with Phytopathologists.

Herbert Osborn
E. O. Essig
G. W. Herrick

The Committee respectfully recommends that the present personnel of the following committees be continued: Nomenclature, Representatives on the Council of the Union of American Biological Societies, Representative on the Board of Trustees of the Tropical Plant Research Foundation.

J. S. HOUSER, *Chairman*
ARTHUR GIBSON
B. A. PORTER
Committee

Voted that the report be accepted and the nominees elected.

PRESIDENT W. B. HERMS: Will Past Presidents R. W. Harned and Arthur Gibson please escort Vice-President E. N. Cory to the Chair, as I believe he is the highest officer present in the new administration?

Past Presidents Harned and Gibson escorted Vice-President-elect Cory to the Chair.

PRESIDENT W. B. HERMS: Professor Cory, in extending to you and your colleagues my personal congratulations, I also do this in behalf of your colleagues of the American Association of Economic Entomologists. I bespeak for you and your administration a year of great success. This is the emblem of your office.

VICE-PRESIDENT E. N. CORY: The next item on the program is miscellaneous business.

MR. S. W. BILSING: I would like to make an announcement. The Cotton States Entomologists and Southern Plant Board and Texas Entomological Society will hold a joint meeting at the Rice Hotel Houston, Texas, February 5 and 6. It occurs to us perhaps some of the members of this Association may be traveling West or South at that time; if so, we extend a cordial invitation to be present at that meeting if they find it possible to do so.

VICE-PRESIDENT E. N. CORY: The next is fixing the time and place of the next meeting.

SECRETARY C. W. COLLINS announced that the American Association for the Advancement of Science was scheduled to meet in Des Moines Iowa, Dec. 27, 1929 to Jan. 2, 1930, and a suggestion had been made by a few of the members that this Association might wish to consider meeting in Ames, which is 30 miles distant from Des Moines. Expression of opinion was invited as to the advisability of meeting in Des Moines, a city of 180,000, or Ames, a city of 10,000. It was brought out that other societies, such as the Phytopathologists and Bacteriologists, were considering meeting in Ames. It was also pointed out that it would be necessary to go to Des Moines in order to have railroad certificates validated to qualify for the half-fare return trip. It was finally voted to refer this matter to the Executive Committee with reference to the advisability of meeting in Des Moines or Ames or both.

VICE-PRESIDENT E. N. CORY: Is there anything else to come before us?

MR. E. O. ESSIG: May I make an announcement? Professor Herms has already told you about the Pacific Slope Branch. We are meeting this year at the University of California, Berkeley, beginning June 19 to 21. If there are any visiting entomologists who contemplate coming to the Coast, we hope you can make arrangements to come so as to attend our meetings. We extend to you open house.

FINAL ADJOURNMENT: 11:40 A. M.

PART II. ADDRESSES, PAPERS AND DISCUSSIONS

The session for presentation of technical papers convened immediately following the business session, Vice-President P. J. Parrot in the Chair.

VICE-PRESIDENT P. J. PARROT: It gives me great pleasure at this time to say that our President, W. B. Herms, will give the annual address.

THE EXPERIMENTAL METHOD AS APPLIED TO ENTOMOLOGICAL INVESTIGATIONS

By W. B. HERMS, *University of California*

ABSTRACT

The experimental method is regarded as "the most important tool of research that scientists employ," hence it is important that this method of investigation should be employed to best advantage by workers in the field of entomology. To illustrate the use of this method experiments are cited in insect nutrition, hydrogen ion concentration, medical entomology, plant diseases, insecticides, and light reactions. The use of high grade instruments for observing, recording and regulating temperature, moisture, air movements, evaporation, humidity, etc., is strongly urged, and a brief account is given of what the author believes to be the necessary qualifications of a worker in the field of experimental entomology.

Thomas Hunt Morgan in "Experimental Zoology" (1907) designates the experimental method as "the most important tool of research that scientists employ." He states further, "The essence of the experimental method consists in requiring that every suggestion (or hypothesis) be put to the test of experiment before it is admitted to a scientific status ..... It is the method of attacking problems that is the chief characteristic of experimental work.....We demand in the case of a problem in experimental science that the conditions under which an event takes place be discovered, and that, if possible, we reproduce artificially the result by controlling the conditions. In fact the control of natural phenomena is the goal of experimental work."

With the control of certain living things (insects) as the objective of economic entomology, it is highly important that the experimental method be used to best advantage,—economic entomologists ought to be experimental entomologists. Entomological literature indicates that we are still decidedly in the descriptive stage of our science. This is not to be condemned since familiarity with the facts concerning structure, development and behavior is essential to a wise application of the experimental method. Morgan (loc. cit.) again illuminates this point for us, viz.: "The carrying out of an experiment implies the formu-

lation of a working hypothesis, and this usually presupposes some knowledge of the possible conditions that control the phenomena. The experimental work becomes more explicit and accurate the more we know beforehand of the possible conditions that may enter into the result.....for the highest order of work there is demanded also great imaginative power. Good judgment and accurate observation may lead to *fine* work, but constructive imagination seems to be required for the highest order of *original* work."

That the writer became early interested in the experimental method is evidenced by the fact that his first published paper was entitled "An ecological and experimental study of Sarcophagidae with relation to lake beach debris." (Herms 1907.) It was in the pursuit of this investigation that I first became interested in the feeding habits, growth and general behavior of flesh flies, particularly their larvae. Growth curves based on the percentage increment of weight of individual *Lucilia caesar* larvae weighed every two to four hours throughout the period of growth indicate that the growth of these larvae is not unlike that of guinea pigs, for example, i.e. the tendency is for growth to decrease in rate uniformly; there is a wave-like rise and fall with a deep trough and a high crest at the beginning of growth which gradually diminish with age. It was also found that within certain bounds there is a close relationship between the size of the adult fly and the amount of food consumed by the larva, the amount being in terms of feeding hours. Underfeeding resulted in undersized flies. Recently the writer (Herms 1928) repeated some of these experiments on *Lucilia sericata* with the following results. (1) Flies originating from larvae having fed on beef lung showed a variation in size from an average wing length of 4.2 mm. for those feeding 42 hours, to an average of 5.4 mm. for those having fed to voluntary migration. However, the longest wing lengths were to be found among those flies having fed 54 to 60 hours, i.e. 6.7 mm. and the shortest wing length 3.3 mm. at 42 hours' feeding. The average size of the females was always greater than that of the males except in the lower feeding range (42 hours and less) when the males showed a slight advantage. (2) The sex ratio of the flies varied according to the length of time the larvae were permitted to feed; namely, those lots which fed until voluntary migration from the food showed a sex ratio of from 2.8 to 3.1 males to 6.9 to 7.2 females, while those which were permitted to feed only 30 to 36 hours showed a sex ratio of from 6.2 to 6.5 males to 3.5 to 3.8 females.

Insect Nutrition

Many if not most of the investigations relating to nutrition and the rate of growth and other developmental phenomena of insects have related to species which feed normally on decaying or putrifying matter. Papers by Richardson (1926) dealing with the Mediterranean flour moth (*Ephestia kuehniella* Zeller) and by Chapman (1924) on the confused flour beetle (*Tribolium confusum* Duval) are noteworthy exceptions. There appears to be considerable evidence that insects which live on decaying or putrifying organic material are dependent upon microorganisms for their nutrition in that these organisms must first put the material in a proper condition for the use of the insect. It has been shown by Guyenot, Baumberger et al that flesh flies, pomace flies and certain other insect species are unable to thrive on the medium which is ordinarily considered their food if it is sterile. Flesh will support *normal* growth in the flesh fly only if it is infected with putrifying bacteria. Eggs of *Lucilia sericata* (washed but not wholly free from contamination) planted on sterile beef agar slants gave rise to larvae which grew very little, all dying in a few days. Repeated experiments of this kind done with bacteriological technique are necessary before definite conclusions can be reached.

Baumberger (1919) reports that larvae of *Drosophila* died after twenty-eight days on sterile banana, while those fed on yeasts completed their larval life and pupated after five days. He shows that on cultures of banana agar infected with living yeast, larvae grew to full size and pupated in about ten days. Other larvae showed very little growth, death resulting in from twenty-four to forty-four days. When media were made up consisting of various percentages of yeast it was found that the rate of growth was proportional to the percentage of yeast, the greatest size being attained in a medium containing 24 per cent of yeast. As the percentage of yeast was reduced the ultimate size of the larvae was reduced and the time required for them to reach maturity was increased. I (Herms 1928) have had similar results with experiments on mosquito larvae as indicated later in this paper.

Although there has been much work done relative to the larval food habits of mosquitoes, and factors that influence growth, we have yet much to learn in this connection. It has been generally assumed that mosquito larvae *ingest* their food in the form of minute living organisms,—plant, animal and bacterial. In order to learn a little more about the nutrition of these interesting creatures the following experiment was tried. As early as 1924 we found that yeast could be used

effectively as a food for certain species of mosquito larvae, particularly *Theobaldia incidens* (Thom.). For breeding purposes battery jars were used, all being autoclaved and covered with sheets of sterile cotton between bobbinet. Access to the jars was gained through a hole protected with a cotton plug. Into each jar was placed a litre of distilled water the pH of which was 6.4 to 6.6. Egg rafts of a previous night's laying were collected and placed in distilled water to hatch. From eight to ten egg rafts were generally used for each series with certain exceptions. The newly hatched larvae were then mixed thoroughly in order to overcome possible differences in vitality. From this mass of larvae, lots of one hundred each (seventy-five in a preliminary series) were transferred to the battery jars, into which fresh, finely cut up Fleischmann's yeast had been previously placed in quantities ranging from .5 gram to 5 grams. Hydrogen ion concentration readings by the use of La Motte color standards were made of the water just before the yeast was introduced, again following this and again after the larvae were introduced. Readings thereafter were made daily alternating morning and afternoon. In each series one jar remained free from both yeast and larvae, another without yeast but with the usual number of larvae.

In order to determine the rapidity with which the yeast cells disappeared counts were made by means of an ordinary haemacytometer. Believing that perhaps lack of oxygen might account for the relatively large mortality of larvae in previous experiments, oxygen was bubbled rather vigorously at intervals for a period into the water containing larvae of one series; no appreciable difference, however, was evident. In addition to fresh yeast, both synthetic and autoclaved yeast were tried.

The results of these experiments may be summarized as follows: (1) Mosquitoes resulting from larvae reared in distilled water (one hundred larvae to one litre) with Fleischmann's yeast showed a variation in average size ranging from an average wing length of 4.0 mm. for .5 gram of yeast, to an average wing length of 4.6 mm. for 5 grams of yeast, although the average wing length of those resulting from larvae reared on 3 grams of yeast was slightly greater, namely 4.7 mm. (2) In general with an increase of yeast there was a shortening of the time required to pass from egg to emergence of the imago (temperature about 73° F. and other factors remaining fairly equal); for 5 grams the time was nineteen days, with 7 per cent emergence; for 4 grams, eighteen days, with 54 per cent emergence; for 2.5 to 3 grams, eighteen days with

53 per cent emergence; for 1.5 to 2 grams, nineteen to twenty days with 74 per cent emergence; for 1 gram, twenty-one to twenty-two days with 13 per cent emergence; and for .5 gram it was twenty-two to twenty-seven days with only 2 per cent emergence; with no yeast all larvae died in three or four days. (3) It is of interest to note that there is indication of a reversal of sex ratio quite opposite to that observed in *Lucilia sericata*, namely for 1 gram of yeast the sex ratio was 3.3 males to 6.7 females, and for 4 grams of yeast the ratio was 5.5 males to 4.5 females. Further work is needed here and a satisfactory explanation for the reversal is not yet at hand. (4) Synthetic yeast consisting of 52 parts casein (protein), 37.3 parts starch (CH), 8.7 parts potassium phosphate (ash), and 2 parts olive oil (fat) gives satisfactory nutrition at the rate of 3 grams to a litre of distilled water, i.e., about as good as a like quantity of fresh yeast, but accumulations of oil on the surface resulted in failure to pupate. (5) Autoclaved yeast(autoclaved from thirty minutes to two hours under seventeen pounds pressure) at the rate of 3 grams to a litre of distilled water resulted in an average emergence of 22 per cent (11 males to 11 females) running almost exactly parallel in every respect with the check experiment.

Studies in the field of insect nutrition are much needed. One illustration will serve to show this need in a given field. At present in biological control operations huge numbers of black scale [*Saissetia oleae* (Bernard)] are necessary for the purpose of rearing parasites for liberation in the citrus orchards of California. The black scale is now being grown on potato sprouts, a method not altogether satisfactory. An artificial nutritive medium on which the scales might be easily reared in large numbers would be a matter of great interest to those engaged in biological control.

Hydrogen Ion Concentration Experiments

Many species of organisms appear to require a certain hydrogen ion concentration range of the medium in which they live. The investigation of this factor became almost a fad within recent years, but withal much has been discovered and more needs to be learned in this field. Here also the experimental method is valuable. My interest in mosquito development led me forthright into this fascinating field and *Thebaldia incidens* was our best subject because it is widely distributed and common in northern California. It breeds in almost all sorts of permanent pools and continues developing throughout the year wherever the water does not actually freeze. This species can be reared easily in distilled water with only yeast as a food, as already mentioned. With

the use of 2.0 to 2.5 grams of Fleischmann's yeast as many as 88 to 96 per cent of newly hatched larvae (one hundred to a lot) were reared to the imago stage. Taking our work as a whole, both buffer solutions in concentrations ranging from a pH of 5 to a pH of 9, and including the yeast experiments already cited, it was found that *Theobaldia incidens* tolerates a pH range of 5.4 to 7.6. On the other hand similar work done with *Anopheles maculipennis* Meig. indicates a much more restricted range. In its natural habitat the pH range of this species varies from 7.3 to 8.6, the mode being 7.6. This range was ascertained by taking readings (from pools containing larvae) in many localities in the Sacramento Valley, California. Yeast, as already stated, does not give as good results with *Anopheles maculipennis* as it does with *Theobaldia incidens*, not over 5 per cent emergence being achieved and then only when the pH was over 7.0, i.e., 7.2 to 8.0. In a recent experiment using autoclaved dried ox blood as food we succeeded in rearing seventeen mosquitoes (eight females and nine males) from one hundred eggs, i.e., 17 per cent, and it is interesting to note that the pH of the fluid was 7.6, the mode of the pH readings made in the natural habitat.

These experiments are but very minor contributions to our limited knowledge of the restrictive action of pH on the life of insects, and are by no means conclusive. However, the method of procedure for certain aquatic species, may be suggestive; a suitable food of known quantity and reaction being first ascertained, perhaps yeast in the case of certain culicine mosquitoes and perhaps dried ox blood for anophelines, then a suitable fluid (buffer solutions) of a known pH in a series ranging from a pH of 5 to a pH of 9, increasing thus; 5.0, 5.2, 5.4, 5.6, 5.8, 6.0, 6.2, etc. to 9. Newly hatched larvae should be used, one hundred to a litre of fluid. For other aquatic insects, the experiment may be adapted to suit the case.

Insect Vectors of Human Diseases

In the study of human diseases transmitted by insects one would ordinarily first determine by experiment whether or not laboratory animals are susceptible. If laboratory animals are readily infected then further experimentation is greatly simplified. No doubt much grief would have been obviated had it been known earlier that yellow fever could be transmitted to laboratory animals. Although human malaria is not transmissible to laboratory animals, an early knowledge of the disease vector was possible because a closely related disease occurs in birds, a study of which gave the key to the famous discoveries of Ross, Grassi, Bignami, and others.

Some years ago insects were suspected of being carriers of infantile paralysis (poliomyelitis). Monkeys are readily susceptible to this disease. By process of experimentation one insect species after another was eliminated,—fleas, bedbugs, etc., but stable flies (*Stomoxys calcitrans*) somehow remained under suspicion for a long time, in fact certain investigators actually announced that the disease had been successfully transmitted by these flies. Then began a long and tedious series of experiments and after nearly a year of painstaking work our negative results were published (Sawyer and Herms 1913).

Well do I remember the test completed December 16, 1919 which proved *Ceratophyllus acutus* Baker (the ground-squirrel flea) to be a transmitter of plague from ground squirrel to ground squirrel. The cage used by the U. S. Public Health Service in San Francisco for the experimental animals was an ordinary galvanized iron garbage can 33 inches high by 19 inches in diameter and suitably screened and smeared with "tanglefoot" to prevent the escape of the rodents and fleas respectively, every possible precaution being taken to obviate danger. Dr. George W. McCoy (1911) describes the experiment, viz:—"A ground squirrel was inoculated subcutaneously with a broth culture of *Bacillus pestis* derived from a human case of plague. This animal died on the fifth day. Three days before its death, one hundred fleas (*Ceratophyllus acutus*) were put in the cage with it. While yet warm the dead rodent was removed from the cage and twenty-seven live fleas were taken from its body. Two of these were crushed, and staining of the resulting smears showed an abundance of pest-like bacilli in each. The twenty-five fleas remaining were put in a clean cage with a healthy squirrel. This animal died of subacute plague ten days later..... This experiment is conclusive in showing that *C. acutus* may convey plague from a sick to a healthy squirrel. It should be stated that all of the squirrels were kept in quarantine for at least a month prior to their being used for the experiment. In fact all of these squirrels were obtained in a region in which no plague squirrels have ever been found."

Experiments in the field of medical entomology call for an unusual amount of care in preventing the escape of infected insects, also much skill and ingenuity are required in many instances to call forth normal feeding responses on the part of imprisoned blood sucking insects. Experiments with Phlebotomus flies, as described by Dr. E. Hindle while in Berkeley recently, in relation to the transmission of Kala Azar are particularly to the point both with respect to the vector and the experimental host, the hampster.

Insect Vectors of Plant Diseases

One of the most fruitful and interesting fields to which the experimental method is particularly well adapted is that of plant pathology. Already many of the hitherto so-called physiological diseases of economic plants have been placed by this method in the category of insect borne diseases. The Cicadellidae (leafhoppers) have been found to be particularly effective vectors. Thus Severin (1929) has found *Eutettix tenellus* (Baker) to be a vector not only of curly top of sugar beets but also a vector of the same disease in the case of potatoes, tomatoes, peppers, horse radish, cabbage, cauliflower, turnip, mustard, parsley, tobacco, buckwheat, okra, and others. Many of these are naturally infected with the disease. In order to test naturally infected plants, Severin and Henderson (1928) used the following method, "Male beet leafhoppers non-infective as to curly top were fed on stunted diseased plants removed from the field, and then transferred to healthy beet seedlings. Males were used rather than females so as to avoid egg deposition. If the beets developed curly top it was evident that the cultivated plants and weeds had been naturally infected with the disease. In each case the number of non-infective males which fed on a plant suspected of harboring curly top varied from ten to twenty-five or more. A high mortality of the insects often occurred in the greenhouse owing to unfavorable food. The hoppers were transferred, according to their death rate, to two or more beets. For instance, when twenty-five males were used and some died, the remainder were equally divided between two cages, each enclosing a beet. If the symptoms of curly top failed to develop in from one to two weeks the beets were examined daily in insect-proof chambers for a period of six weeks. Checks were often used in which apparently healthy cultivated plants or weeds were removed from the field, and cross inoculations were made with non-infective leafhoppers feeding on the plants, to beet seedlings.

"A large number of cultivated plants and weeds were experimentally infected with curly top so that the symptoms of naturally infected plants could be recognized in the field. The plants were grown from seeds in a greenhouse which was fumigated twice a month with nicotine sulphate. From two to ten infective male beet leafhoppers confined in cages were used to inoculate the plants, the number depending upon the size of the plant. When the longevity of the adults was short because of unfavorable food, the plants were repeatedly inoculated with different lots of males. The period allowed for inoculation was usually two weeks, or less, if symptoms of curly top developed earlier.

After the period of inoculation, the cage containing the infective males was removed from the plant. In another cage non-infective males were fed on the inoculated plant, for a period of at least two or three days, or longer if the food material was unfavorable. The leafhoppers were then transferred from the inoculated plant to healthy beet seedlings. If the beet developed curly top, it was evident that the inoculated plant had been infected with the disease."

Like the field of medical entomology, this field (insect borne plant diseases) calls for a high degree of skill and ingenuity in manipulating both the very tiny insects and the plants under experimentation. In their filtration experiments both Carter (1927) and Severin and Swezy (1928) fed their leafhoppers on liquids enclosed by a fish swim-bladder sack suspended in a cage using light to direct the insects to the food. The transfer of leafhoppers from cage to cage is made easy by the use of a ten cubic centimeter bulb pipette attached to a rubber tube. By inhaling a breath of air through the rubber tube, the hoppers are drawn into the bulb of the pipette and by exhaling the breath they are expelled from the pipette into another cage or into a vial.

The field of insect borne plant diseases is rapidly developing and is not adequately covered either in our courses in economic entomology or plant pathology and like medical entomology needs to be given special consideration. Courses in this field will soon be given in many of our larger universities.

Efficacy of Chemicals

No doubt many present at this meeting recall with enthusiasm the striking paper by R. H. Smith (1926) entitled "The efficacy of lead arsenate in controlling the codling moth." The introduction to Smith's paper is equally applicable to any other insecticide. It reads, "The investigator who undertakes an orchard spraying experiment for the purpose of determining the value of one or more elements in the spraying method of controlling the codling moth, *Carpocapsa pomonella* (Linn.), is confronted by a large number of unknown and uncontrollable factors which influence in various ways and degrees the results of his experiment. Conclusions arrived at under such conditions of experimentation are likely to be lacking in explicitness and accuracy, and they may sometimes be wholly erroneous. It is a well known fact that the vast literature on codling moth spraying is replete with contradictory experimental data, and discordant opinions and beliefs. A number of points of primary importance regarding this method of control have continued to remain largely in the realm of assumption and theory

ever since spraying was first employed in codling moth control nearly fifty years ago. Spraying tests have been confined almost without exception to orchard conditions."

Economic entomologists interested in the efficacy of spray materials or the development of new insecticidal sprays would do well to study carefully the "Methods and Technique" which Smith employed in his investigation. Only that portion dealing with the transfer of the larvae to the apples need be quoted here to illustrate the point. "Many factors relating to the transferring of the larvae were found to make for error in the results. There was often much variation in the vigor and size of different larvae, even among those hatching at the same time. Larvae hatching between dawn and about ten o'clock in the morning seemed to be stronger and more likely to produce injuries than those hatching at mid-day or during the afternoon. The first larvae to hatch from a given lot of eggs showed greater vigor than those last to hatch. It also seemed that larvae hatching from eggs whose development had been retarded by being placed in a room with a temperature of about 50° F. were less vigorous than those whose development in the egg had been unchecked. In order to equalize this variation in vitality, the larvae were transferred to the apples in rotation. Five larvae were placed on the first apple, five on the second apple, five on the third, etc., until each apple of a series had five larvae. This was then repeated until a total of twenty-five larvae had been transferred to each apple.

"A finely pointed artists' brush, size No. 1, was used for handling the larvae. The brush was kept soft and flexible by moistening it frequently. Considerable care had to be exercised in order to place the larva ventral side down on the apple so that it could make contact with the surface with its legs and spinneret. In case of the spotted coverages an endeavor was made always to place the larvae on the areas between the deposits of poison. Twenty-five larvae to each apple was the standard number used. Special tests were made in which the number ranged from five to two hundred per apple."

A well planned field experiment on a laboratory basis conducted by Freeborn and Wymore (1929) may serve to further illustrate the point in question. This experiment concerned the use of certain chemicals to prevent attacks of the corn earworm [*Heliothis obsoleta* (Fabr.)]. Ten thousand individual ears of two varieties of sweet corn were tagged and numbered and tabulations were made of the developmental stage in each case at the time the chemical was applied. Thirty-three rows of each variety of corn were used in the test. Nine rows were reserved for

controls, namely the three outer rows on each side and the three middle rows in the field. Twelve chemicals were tried, one on each row, and the experiment was duplicated on each side of the middle control rows except that the material used on the outer row on one side was on the row next the center on the other side. In this way each material was tried four times, twice on each variety and in a different portion of the field on each occasion. A final checking up of the experiment indicates that of the twelve chemicals used ordinary black pepper (an unorthodox remedy) proved to be one of the best to give protection to the corn.

Light Reactions

In the daily pursuit of our entomological investigations we are constantly reminded of the important rôle that light plays in the behavior of insects. Students of animal behavior have been able to contribute much to this subject through experimentation with insects in relation to light, notably Loeb, Holmes, Parker, et al. Yet we are far from understanding these powerful relationships and have hardly begun to realize the possible use of light as a means of insect control. Both laboratory and field investigation are necessary in the study of this problem. Behavior of individuals must be well determined in the laboratory as well as the behavior of aggregations if possible, since there may be striking differences. There may also be striking differences in the field behavior of insects as observed in the codling moth.

During the past summer we have conducted a field test of the effect of artificial light on the egg laying habits of the codling moth. An account of this test will be given in some detail later during these meetings (Herms 1929), hence it is unnecessary to state more than that light of the intensity and quality used in the test plot showed a substantial repellent effect on the codling moth, thus affording some protection to the apples. Given an optimum temperature, we have yet to learn the optimum light intensity in which the codling moth deposits its eggs most freely. It will be observed that unless light of a sufficiently high intensity is used there is danger of producing an intensity that will simply prolong the optimum intensity and result in prolonging the working hours of the female insect, thus increasing the percentage of moth damaged apples.

Chaoborus lacustris Freeborn is an almost unbelieveably abundant gnat during the summer along the shores of Clear Lake at Lakeport, California. These gnats develop as "phantom larvae" in the deeper water of the lake and at some distance from shore, hence control in the larval stage offers great difficulties. On the other hand, the gnats are

strongly attracted to lights, which linked to the fact that these insects come to the shore to mate and then fly out upon the water to lay their eggs, gave the idea of trapping more than ordinary importance (Herms and Burgess 1928). All ordinary light traps quickly became hopelessly clogged with gnats, hence the use of a suction fan in addition to a 300-watt lamp, and a long sleeve or bag as a receptacle to receive the insects. Some idea of the effectiveness of this device may be obtained when it is known that on two occasions eleven pounds of gnats were trapped in two hours in one trap and a total of one hundred fifty-six pounds for the season.

Insect Physiology

As a field for experimentation none is quite so inviting as that of insect physiology. Here we have a field in which the workers are few and opportunity for discovery is met at every hand. The internal anatomy of insects consists largely of a list of organs of unknown function. That the name of an organ bears the name of a human organ is no evidence that its function is the same. Time is too short and in particular my knowledge is too small to do more than throw out a challenge to the younger generation of entomologists now in the making, and may their "makings" include much of chemistry and physics.

There is perhaps a sufficient reason why the physiology of insects has so largely remained undeveloped. No doubt, the high development of human physiology is largely due to man's struggle to overcome disease. Who wants to keep a "bug" free from disease, anyway? Let it die, the sooner the better. Let the insects develop their own doctors, we are here to destroy them! Such might be the defense on our part, but perhaps a knowledge of the physiology of insects might help man to find ways that will cause the dangerous insects to die off faster and the beneficial forms to live longer, and after all isn't it worth while to make more perfect our understanding of "a subject as yet so imperfectly understood?" These words are quoted from a recent article by Thorpe (1928) with reference to the elimination of carbon dioxide in the Insecta.

Equipment

To even the most casual observer, it must soon become obvious that the problem of ways and means, i.e. equipment, looms large in the application of the experimental method. The biologist is not as a rule well fortified in the fields of physics and chemistry in which sciences, ways and means are most commonly to be found. Fortunately, the economic entomologist has long since learned that ability as a "handy man" is much to be cherished, but the ways and means of a handy man are not

usually highly refined, hence much crudity has found its way into what little experimental work has been done in this field. On the other hand economic entomologists are usually good cooperators, hence may be expected to work well with other scientific workers who do possess the necessary technical knowledge. Experience, however, proves that the many special contrivances needed in this field must be devised by our own workers, but with proper advice from technical sources. Such special equipment as I have in mind is illustrated in certain contributions by Shelford (1927) and McIndoo (1926). Shelford's statement concerning his equipment for certain codling moth investigations is apropos: "We know of no other attempt to use variable temperatures of an interpretable type, with factors all recorded, as a means of bridging the gap between constant-temperature experiments and actual weather conditions. The chambers for constant-temperature work are unique in that they allow the use of several humidities at the same temperature. This feature is essential because variation in stock necessitates the running of a large series started at the same time from the same stock. This is a very important feature of climate-simulation work."

Much patience, foresight, skill and imagination are required in developing the "set up" of the experiment. Plans must be well laid and only the best of instruments used, otherwise little is to be gained and much time is wasted. Various types of high grade instruments are now readily available to our workers for observing, recording and regulating temperature, moisture, air movements, evaporation, humidity, etc.

Qualifications

The field of experimental entomology is not recommended for one who habitually begins his work at a given hour in the morning and quits at a given hour in the afternoon, nor to the one who must have his holidays and Sundays as they come. Indeed, the average economic entomologist is in many respects well fitted by experience to more fully occupy this field. It is an ideal field for the well foundationed entomologist who has much patience, a substantial sense of humor, good imagination, endowed with the virtue of accuracy, has mechanical skill, loves to work with living animals, enjoys the suspense of impending results and can stand the shock of a long series of experiments ending in fiasco. If you have reared even ten pedigreed flies from the egg, watched each one hatch, have tested each larva at intervals of a few hours, have watched them through pupation, have marked each fly as it emerged and have begun to test each fly and suddenly one of these flies escapes in

a great big dark room full of all sorts of things,—then you know what I mean, or even if one of your fly-bitten monkeys (non-infected) suddenly escapes and ends up in a huge gymnasium, then too you will know something of the trials of an experimentalist. Yet I do heartily recommend to you the use of the experimental method as "the most important *tool* of research" that you can employ. I am also confident that courses in "experimental entomology" yet to come will give us and our students the greatest of joy and will greatly enrich our science to the profit of those whom we serve.

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VICE-PRESIDENT P. J. PARROT: The President's paper is now open for discussion. I certainly want to express my hearty approval of the selection of the topic chosen by President Herms, a topic, which, by the way, covers a very important field of entomological endeavor and to my knowledge has never been covered exhaustively, at least in any preceding presidential address; as well as to congratulate him on his excellent discussion of the subject. I think most of us are all aware of the fact that most of the simple problems in entomology have been handled. We are confronted with the difficult problems and even to get data that will hold water with such a problem as the codling moth is a puzzling one and calls for time and men and equipment, technical ability and experimental methods that must certainly seem surprising to those who are familiar with the conditions under which older entomologists worked. I have no doubt at all but that the address has suggested many topics that our members would like to develop further, if so, opportunity will now be given to make comments.

While some members are thinking what they would like to say, I would also point out in the case of insects and plant diseases, we are tremendously interested, President Herms, in our studies of tree crickets and inoculation of plants with diseases. It is an insect that is most abundant in all areas of the country and one which is excellent laboratory material for the demonstration of what insects can do along those lines. It is a thing I often wondered about, that it has not been considered further in the teaching of the role that insects play in dissemination of diseases.

MR. W. E. BRITTON: I wish to offer my congratulations to Professor Herms and also to the members of the Association for this splendid address. Many suggestions in it will be valuable to us all. While some of us older entomologists may not be able to carry them out, I have no doubt in the future we shall have men, young men properly trained, who will be able to solve many of these problems.

MR. A. F. BURGESS: I think Dr. Herms has covered the field that perhaps is only covered slightly by many of the entomologists in this country, a field in which there are vast possibilities, and I presume a good many of the members hesitate to discuss some of these matters because they are more interested and have devoted more of their time to other lines, rather than to the lines outlined here. I believe we all appreciate the value that has been given to us in this address. I think that you all appreciate the fine work that is being done by the entomologists on the Pacific Coast, although we seldom have opportunity to meet very many of them. If I recall correctly, this is the first meeting of this Association that has been addressed by a member from the Pacific Coast as its President.

I want to congratulate Professor Herms on the address. I think he has given us many thoughts and suggestions that are of value, and I hope that some of the entomologists in the East may carry on and extend a lot of the work that he has outlined, because I believe the field hasn't been covered as thoroughly as it should be by the entomologists.

MR. A. C. BAKER: I have greatly enjoyed the President's talk since it touches a subject that is close to my own heart. But I feel also that the subject treated is by far the most important one facing the profession at the present time. There is one point I wish to emphasize among those brought out in the address. This deals with the necessity of making the results of field experimentation approach in accuracy those of laboratory experimentation. In the laboratory where influencing factors can be controlled, it is not an exceedingly difficult task to obtain positive and relatively accurate results. From the nature of our work, however, very much of it must be conducted in the field where influencing factors cannot be in any way controlled. It is highly essential, therefore, for us to utilize in our field work methods devised for working with data that are influenced by constantly varying factors in the same way that is necessary for us to utilize in our laboratories apparatus designed for the control of influencing factors. And I am inclined to think that some of the difficulties we have with our field experiments are due to the fact that we do not use sufficiently the methods which have been developed precisely for this purpose. These methods when used judiciously will assist us in getting out of our field experiments conclusions at least approaching in accuracy those that may be obtained from laboratory experiments. This point I wish to emphasize, for otherwise an attempt at much greater accuracy in our work would in many cases appear hopeless.

MR. ARTHUR GIBSON: May I add my word of thanks to this? I personally have enjoyed it very much indeed. When I was in California two years ago, I had the opportunity, when President of the Association, of attending the Pacific Slope Branch at that time. Dr. Herms and his associates at the University of California very kindly gave us an opportunity of seeing something of the work which he told us about this morning. On that occasion, too, I also had an opportunity of seeing some of the work of Mr. Ralph Smith and I simply want to add my word of thanks for this very excellent address.

MR. GEORGE A. DEAN: I want to add my little mite to the congratulation of Dr. Herms on this most stimulating address. It seems to me he has covered it in such a comprehensive manner that it hasn't left anything for anyone in my position at least to discuss in an adequate manner, but I do want to congratulate him and this Society, too, that we have among us a man capable of giving such a stimulating address as we have just heard.

MR. J. G. SANDERS: I particularly appreciate the paper which has been read by our President. I personally know that he has brought to us the results of at least 25 years of continuous work along this line. It was my privilege, 24 years ago, to observe this line of work as carried on by our President. I want to bring this fact to some of the entomologists who possibly didn't appreciate the results which have been brought to us this morning in a few minutes and which have really been the out-growth of a quarter of a century of effort.

VICE-PRESIDENT P. J. PARROT: I will call for the next paper.

FACTORS AFFECTING THE FEEDING RATE OF *RODOLIA CARDINALIS* MULS

By A. W. CRESSMAN, *New Orleans, La.*

(Withdrawn for publication elsewhere)

ADJOURNMENT: 12:25 noon.

Friday Afternoon Session, December 28

The session convened at 1:40 p. m., President Herms presiding.

PRESIDENT HERMS: The first paper on the afternoon's program is by E. A. Siegler, Luther Brown, M. A. Yothers, and W. P. Yetter, Jr.

FURTHER OBSERVATIONS ON THE USE OF CHEMICALLY TREATED CODLING MOTH BANDS

By E. A. SIEGLER, LUTHER BROWN, M. A. YOTHERS, and W. P. YETTER, JR.

(Withdrawn for publication elsewhere)

PRESIDENT W. B. HERMS: The next paper is by C. R. Cutwright and J. S. Houser.

A LABORATORY METHOD FOR DETERMINING THE ATTRACTIVENESS OF BANDS TO CODLING MOTH LARVAE

By C. R. CUTRIGHT and J. S. HOUSER, *Ohio Agricultural Experiment Station, Wooster, O.*

ABSTRACT

The laboratory method is described and reasons for its advantages are given. Tables showing the type of results are also included.

Published and unpublished data dealing with the codling moth are full of conflicting statements regarding the efficiency of different types of bands in trapping the mature larvae of this insect. That these contradictory results exist is evidence of the fact that workers have conducted research under dissimilar conditions and also that the many factors influencing variation have not been properly evaluated. Most work dealing with bands has been conducted in the field, where contributing factors can be but partly controlled and are especially hard to measure. The elimination of the confusing factors is, therefore, very much to be desired and this we believe has been accomplished by devising a simple laboratory method, in which conditions, for the most part, are under control. In this method, posts of sawed lumber similar in size, shape and material are substituted for the trunks of growing trees upon which the bands are usually tested. These posts are arranged in pairs and as many series may be used as the size of the experiment demands. Moreover, replication or multiplication of any given trial is simple. These posts are placed upright in the soil out of doors or may be mounted on pedestals for indoor use. In either case these are placed where the same amount of light is available. The two kinds of bands whose efficiency in attracting and retaining codling moth larvae is to be determined are then placed on the posts according to the following scheme.

On post No. 1, Band A is placed about six inches from the top with Band B about six inches lower. On post No. 2 Band B is given the top position with Band A underneath. The base of each post is surrounded

by a band of tree tanglefoot or a box barrier. A given number of larvae that have recently left the fruit is then placed on top of each post and each larva permitted to seek its own cocooning quarters.

After the larvae have been on the posts long enough to take up permanent positions, the experiment is scored in the following manner. The total number of larvae found under both A bands is balanced against the total found under the B bands. The group of bands that has attracted and retained the largest number of larvae is thus indicated as being most efficient. When using the posts out of doors most uniform results have been secured by liberating the larvae in the evening rather than during periods of bright sunlight. Larvae also act more nearly normal if a few are placed on the post at one time instead of the total number being deposited en masse. It is not the purpose of this paper to give detailed results secured by this method but a few tables showing the type of results obtained may not be out of place.

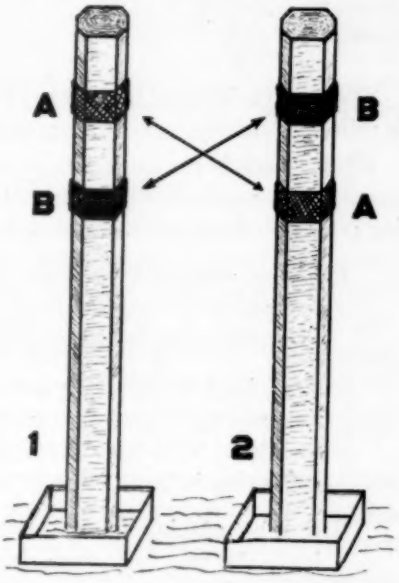

Fig. 1.—Arrangement of posts and bands in testing reactions of mature codling moth larvae.

Table 1 shows the results of trials to determine the efficiency of dry burlap bands in comparison with wet bands of the same material.

TABLE 1. WET VS. DRY BANDS

	Percentage of Larvae Under	
	Wet Bands	Dry Bands
1st trial	18%	82%
2nd trial	15%	85%
3rd trial	25%	75%
Average	19.3%	81.6%

Table 2 shows that corrugated board bands treated with beta-napthol have a repellent effect when checked against untreated bands of the same material.

TABLE 2. TREATED VS. UNTREATED BANDS

	Percentage of Larvae Under	
	Treated Bands	Untreated Bands
1st trial	33.1%	66.2%
2nd trial	42.9%	57.1%
3rd trial	33.1%	66.2%
4th trial	40.0%	60.0%
Average	35.2%	64.8%

The results obtained in tests as illustrated above show that the method is reliably uniform, and is adapted for use in testing any type of band.

While there is no intention of discussing the confusing factors that enter into experiments conducted under orchard conditions, the following points in favor of the laboratory method may be noted:

First, by using sawed posts of equal shape, etc., we eliminate the unequal size, contour, shape, roughness of bark and branch position that exist in all orchard trees.

Second, by placing the posts in equal light position, the factor of unequal lighting of the trunk as caused by branches and foliage is avoided. This also corrects the unequal amounts of moisture collecting in bands due to heavy or light shading.

Third, by placing known numbers of larvae on the posts we eliminate the two very confusing factors of unequal crop and unequal infestation per tree that always exist in orchards.

Fourth, by placing the bands as described above, the larvae have a second choice in case the top band is not suitable. In case neither band is suitable they will be caught in the tanglefoot or box barrier.

MR. W. P. FLINT: "In our work in Illinois this year we tested a number of materials including Beta Naphthol. We secured a better kill with bands treated with Beta Naphthol dissolved in benzene and with Monochlornaphthalene and with Orthotoluidine. The latter two materials, however, have caused rather severe injury."

PRESIDENT W. B. HERMS: The next paper is by W. S. Regan.

THE UNSPRAYED CHECK TREE AS AN INDICATOR OF SEASONAL CODLING MOTH ACTIVITY

By W. S. REGAN, *California Spray-Chemical Co., Yakima, Wash.*

ABSTRACT

Frequent and regular thinning of check trees, in connection with Codling Moth (*Carpocapsa pomonella*) control tests, has the advantage of preventing infestation of adjoining test trees, and in addition gives a fairly accurate record of worm activity throughout the season. Evidence of continuous worm work in moderately to heavily infested districts in the Northwest is presented. Results with the omission of the calyx spray suggest the possibility that this spray may not be as important under Northwest conditions as quite generally supposed.

OBJECT OF FREQUENT THINNING

During the past several years it has been our practice in Codling Moth control experiments to leave for observation and comparison unsprayed trees, commonly called check trees, in the block of orchard in which the tests have been carried out.

This is a common practice and is necessary, in order that a comparison may be made between the control results with any particular test or spray schedule and the normal worm infestation, where no spray has been applied.

It will be readily seen that if unsprayed check trees are interspersed through the test blocks, and worms on these unsprayed trees are permitted to mature and produce moths, the surrounding tests are certain to be subjected to this outside infestation, which may be of such an important character as to seriously handicap any particular test subjected to it.

The importance of this factor will be appreciated when it is understood that a single unsprayed Winesap tree in our test orchard at Sawyer, Wash., in 1926, produced a total of 1324 worms, in spite of six periodical thinnings during that growing season, at each of which every apple found with a "sting" or worm was removed and the worms destroyed. Also a single unsprayed Jonathan apple tree in our Buena, Wash., test orchard, in 1928, produced 2,013 worms, in spite of eleven thinnings, each only ten days apart.

Because of this evident danger of infestation to the test trees from the unsprayed check trees, it has been our practice, begun in 1926, to thin periodically, removing each time every apple having a visible "sting," side or calyx worm, and, after proper determination, to destroy all infestation by submersion of infested fruit in a barrel of water with a heavy surface film of oil.

This practice of thinning was carried out at rather irregular periods in 1926, at regular 14 day intervals in 1927 and at 10 day periods in 1928. In addition, all of the check trees were banded, the bands gone over at ten day intervals, and all the worms found under them destroyed. While this practice of thinning and banding can by no means be considered infallible, in that some moths are certain to escape, it nevertheless reduces to a minimum this source of infestation for the adjoining test trees. These frequent thinnings, furthermore, permit a fairly accurate check on brood activity throughout the season, but naturally reduce greatly the normal infestation that might be expected on the unsprayed trees, if the thinning and banding practice were not carried out.

Results of Thinnings

In the following three tables, are given the results of various thinnings on a single unsprayed check tree in our test orchards during the past three years; a Winesap in 1926, a Rome in 1927 and a Jonathan in 1928. It should be stated that these trees were located in orchards having little, if anything, more than average infestation for these particular districts.

Table 1. Results of Thinning Unsprayed Check Tree, 1926

(Winesap—Sawyer, Wash.)

Date of Thinning	Time Between Thinnings	No. Apples Thinned for Worms or "Stings"	Number "Stings"	Number Worms	% Calyx Worms of Total Worms
1. May 18		21	0	21	?
2. June 19	32 days	162	36	134	?
3. July 5	16 days	136	47	91 (23 calyx)	25.2
4. July 15	10 days	142	47	143 (17 Calyx)	11.1
5. Aug. 7	23 days	168	28	154 (66 calyx)	42.8
6. Aug. 24	17 days	172	25	150 (86 calyx)	57.0
7. Sept. 9	16 days	191	38	259 (73 calyx)	28.0
Oct. 6	27 days	234	13	372 (150 calyx)	40.3
(fruit picked—380 apples on tree)					
Total		1226	234	1324 (Average for 6 thinnings)	34.%

Per cent of fruit with "stings" and worms	Per cent calyx worms of total worms	Per cent of total apples with calyx worms
89.3	34.0	30.2

On this unsprayed Winesap tree, reported above, "stings" or worms were found on approximately 90 per cent of the fruit, a very large portion of which would have been culled by the ordinary system of fruit warehouse sorting. This is astounding in view of the fact that the Winesap is one of the varieties usually least susceptible to Codling Moth attack, and further because at each thinning the fruit was so treated that there was no opportunity for reinfestation.

The calyx worms on this tree amounted to over 34 per cent of the total number of worms found, with a slightly lower percentage of the fruit infested with calyx worms.

TABLE 2. RESULTS OF THINNING UNSPRAYED CHECK TREE, 1927
(Rome—Yakima, Wash.)

Date of Thinning	Time Between Thinnings (approx. 14 days)	No. Apples Thinned for Worms or "Stings"	Number "Stings"	Number Worms	% Calyx Worms of Total Worms
1. June 25		59	8	58 (8 calyx)	13.7
2. July 9		83	6	88 (14 calyx)	15.9
3. July 23		53	10	46 (22 calyx)	47.8
4. Aug. 6		20	2	19 (5 calyx)	26.3
5. Aug. 20		108	9	117 (3 calyx)	2.5
6. Sept. 3		87	5	96 (9 calyx)	9.3
7. Sept. 17		47	12	42 (18 calyx)	42.8
Oct. 1 (fruit picked—728 apples on tree when picked)		41	11	36 (4 calyx)	11.1
Totals		498	63	492 (83 calyx)	Average 21.2%

Per cent of fruit with "stings" and worms	Per cent calyx worms of total worms	Per cent of total apples with calyx worms
40.6	21.2	6.7

On this unsprayed[1] Rome tree, reported above, "stings" and worms were found on 498, out of a total of 1226 apples on this tree, or 40.6 percent. Although calyx worms constituted 21.2 per cent of the total number of worms found (side and calyx), only 6.7 per cent of the total

[1]Check trees were thinned for "stings" and worms only, no attempt being made to space fruit, as in the case of regular thinning.

number of apples on this tree had calyx worms. It should be kept in mind, however, that the frequent thinnings greatly reduced the normal infestation that might have resulted, had the worms been allowed to develop and produce moths for reinfestation.

TABLE 3. RESULTS OF THINNING UNSPRAYED CHECK TREE, 1928
(Jonathan—Buena, Wash.)

Date of Thinning	Time Between Thinnings (approx. 10 days)	No. Apples Thinned for Worms or "Stings"	Number "Stings"	Number Worms	% Calyx Worms of Total Worms
1. May 28		10	0	10 (0 calyx)	0
2. June 9		36	17	35 (5 calyx)	14.2
3. June 19		126	16	136 (71 calyx)	52.2
4. July 1		138	12	157 (40 calyx)	25.4
5. July 9		46	19	48 (9 calyx)	18.7
6. July 19		170	9	193 (24 calyx)	12.4
7. July 30		261	31	281 (48 calyx)	17.0
8. Aug. 8		168	21	173 (43 calyx)	24.8
9. Aug. 18		143	67	136 (20 calyx)	14.7
10. Aug. 28		160	25	164 (54 calyx)	32.3
11. Sept. 7		93	9	102 (26 calyx)	25.4
Sept. 13 (fruit picked—1545 apples on tree when picked)		381	86	392 (64 calyx)	16.3
Fruit on ground at picking time—380 apples		180	12	186 (74 calyx)	39.7
Totals		1912	324	2013 (478 calyx)	Average 22.5%

Per cent of fruit with "stings" and worms	Per cent calyx worms of total worms	Per cent of total apples with calyx worms
52.2	22.5	13.0

On this unsprayed Jonathan tree, reported above, "stings" and worms were found on 1,912 apples, out of a total of 3,657 apples on this tree,

or 52.2 per cent, in spite of the numerous thinnings and in spite of the fact also that this tree was located at about the middle of the experimental orchard, in which the poorest of sixteen spray tests showed a cullage for worms and "stings" of only 8.6 per cent of the fruit at harvest time.

Although the calyx worms constituted 22.5 per cent of the total number of worms found on this tree (side and calyx), only 13 per cent of the total number of apples had calyx worms.

Comparisons and Deductions

From an examination of the preceding tables it will be noticed that the degree of infestation on these three unsprayed check trees varies greatly; the Winesap showing the heaviest infestation, the Jonathan next and the Rome the least infestation of the three. This is by no means an ordinary condition, based upon general experience as to the susceptibility of these three varieties to Codling Moth attack. The Winesap is considered the least susceptible, the Rome considerably more so and the Jonathan the most susceptible of the three, although under average conditions there may be little difference between the Rome and Jonathan in this respect. However, seasonal conditions, degree of infestation in any particular orchard, manner and time of thinning etc., are all factors that may influence the infestation on any check tree, which will readily explain these differences.

It will be noticed in Table 1 that the smallest number of apples removed for worms and "stings" at any one thinning of the Winesap check tree was 136, after a period of sixteen days; that 20 apples was the smallest number removed for worms and "stings," in a fourteen day period, on the Rome (Table 2), and 46 apples the smallest number removed from the Jonathan check tree, after a ten day period, once the brood was well started (Table 3).

The foregoing records throw light on the extent to which fruit, in moderately to heavily infested districts of the Northwest, is continually subjected, throughout the season, to Codling Moth attack. They also undoubtedly explain, in a large measure, (excluding poor spraying), the cause for frequent failures to satisfactorily control this pest, especially where the practice is followed of making intermittent spray applications according to so-called "spray dates," rather than following a regular ten to twelve day schedule for applications, in order to keep the growing fruit continually covered until the brood is thoroughly under control.

The calyx spray has long been considered a most important spray. Results of tests during the past three years, with several common varieties (Winesap, Jonathan, Rome, Delicious, etc.), where the calyx

spray has been intentionally omitted, and the first application made and completed before the first[2] eggs hatched, give cause for questioning whether this long accepted idea is correct, at least under Northwest conditions, where frequent and thorough spraying is practiced.

It is evidently true that any orchardist who, through ineffective or ill-timed spraying, fails to obtain control and has "lots of worms," will, without doubt, have many more side worms than calyx, but will have a calyx infestation somewhat porportional to the total worms present. It is equally true that any orchardist, who by effective work, controls side worms (it can be and is done), will have a correspondingly small percentage of calyx worms, even though no calyx spray has been applied (unless moths are present at calyx spray time, which is relatively rare in this section). This statement applies to the use of Arsenate of lead and oil combination, Arsenate of lead and spreader and to Arsenate of lead alone, although with greater force, possibly, to the lead-oil combination because of its conceded greater effectiveness.

In a series of twenty spray tests on Winesaps in 1926, in none of which a calyx spray was applied (calyx sepals tightly closed when first application made), the percentage of calyx worms found was negligible, only three being found in an examination of 21,522 apples. The unsprayed check Winesap tree in this same test orchard had calyx worms in a little over 30 per cent of the fruit.

Again in 1927, in several spray tests on Romes, some of which, by the way, could not be considered to have given any more than fair control, calyx worms were found in only 1.2 per cent of the fruit in these tests, in spite of the fact that no calyx spray had been applied. On the other hand, an adjoining unsprayed Rome check tree, showed a calyx infestation of 6.7 per cent of the fruit, in spite of seven thinnings, only fourteen days apart.

The calyx spray was again omitted in sixteen spray tests on Jonathans in 1928, with the result that there was an average calyx infestation of only .47 of one per cent of the fruit, in a count of 20,287 apples. In contrast, the unsprayed Jonathan check tree in this block showed a calyx infestation of 13 per cent, in spite of eleven thinnings at ten day intervals.

It is not the intention, in presenting these results with the omission of the calyx spray, to advocate a general modification of a long established practice, by suggesting the omission of this application. This

[2]Moth prevalence is determined by the use of bait pots, and egg laying by evening temperatures.

might entail serious consequences in many cases. It is a fact, however, that some reputable and experienced orchardists in the Northwest are omitting the calyx spray, when seasonal conditions indicate no moth activity at this time, and have not suffered in the least by doing so.

These results with the omission of the calyx spray may possibly be attributed to the use of modern spraying equipment, of high power and pump capacity, which permits very thorough work—with proper inclination on the part of the operator holding the spray gun. At any rate they suggest a careful revision of the conception concerning the calyx, as the "most important spray."

DR. T. J. HEADLEE: For two years we have had a similar experience to that which has just been outlined by the speaker in the work at Glassboro, N. J. It seems to us that the freedom experienced under those conditions is dependent upon the maintenance of a thorough anti-codling moth spray during the period of entry by the larvae of the codling moth. If during those periods the coating is not maintained, there appears larger infestation in the calyx where the calyx spray was not applied.

PRESIDENT W. B. HERMS: The next paper is by W. S. Hough.

FURTHER STUDIES ON THE RELATIVE RESISTANCE TO ARSENICAL POISONS OF CODLING MOTH LARVAE

By W. S. HOUGH, *Winchester, Va.*

(Withdrawn for publication in Journal of Agr. Research)

MR. E. A. SIEGLER: I would like to ask Dr. Hough if he noticed that the Colorado moths were more prolific than the Virginia moths.

MR. W. S. HOUGH: No. Under Virginia conditions, the Colorado moths did not lay any more eggs per female than the Virginia moths.

MR. WILLIAM MOORE: Did you compare Colorado larvae reared in Virginia from the first importation with larvae from the last importation? If so, was there any difference?

MR. W. S. HOUGH: In the first slide (Exp. 4) there were two groups of Colorado larvae designated as "(a)" and "(b)". The "(a)" group descended from the first importation which was in April, 1927. They were reared through two generations in the summer of 1927. The "(b)" group was the first generation from larvae imported in October, 1927. The difference in the length of residence in Virginia did not make any difference in the two groups.

MR. A. C. BAKER: I would like to ask Mr. Hough if he has tested these larvae with a poison to which the population has not been accustomed at all?

MR. W. S. HOUGH: I have not.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by F. B. Herbert and M. D. Leonard.

OBSERVATIONS ON THE OIL-NICOTINE COMBINATION FOR THE CONTROL OF THE CODLING MOTH AND OTHER APPLE INSECTS IN THE PACIFIC NORTHWEST

By F. B. HERBERT, *Entomologist for Balfour, Guthrie & Company, San Francisco, Calif.*, and M. D. LEONARD, *Entomologist for The Tobacco By-Products and Chemical Corporation, Louisville, Kentucky*

ABSTRACT

Two years of experimental work in the Pacific Northwest indicates that a combination of oil and nicotine may have an important place in the apple spray program. Satisfactory and, in most cases, economical control of codling moth, *Carpocapsa pomonella*, as well as the other more important apple insects present has been obtained. The spray residue problem was considerably simplified and the grade of fruit was frequently raised as a result of the use of this spray combination.

INTRODUCTION

During 1915 and 1916, F. E. DeSellem carried on some experimental work at Yakima, Wash., with nicotine sulfate for the control of the codling moth. His results were so encouraging that in 1917 similar experiments were conducted by the U. S. Bureau of Entomology in Colorado, Michigan and New Mexico. Altho the results obtained were on the whole fairly satisfactory, there was at that time no spray residue problem and the greater cost of the nicotine as compared with arsenate of lead hardly seemed justified. Further experiments were therefore discontinued. No observations were made at that time as to any change in percentage of the grade of the fruit due to the use of nicotine.

In 1927 the senior author applied oil and nicotine to several plots of apples in a very wormy section of the Santa Clara Valley, California, obtaining results in the control of codling moth equal to those with arsenate of lead even where one critical cover spray was omitted. During the same year Mr. DeSellem, in cooperation with The Tobacco By-Products & Chemical Corporation and the Wenatchee District Co-Operative Association again took up some experimental work with nicotine sulfate at Wenatchee, Washington. Either "Black Leaf 40"

alone or in combination with a casein spreader gave results against the codling moth comparable to those obtained with arsenate of lead. The use of summer oil with "Black Leaf 40" gave better results on every plot than those obtained with arsenate of lead.

In these experiments a plot in each of three orchards was sprayed with "Black Leaf 40," 1 pint, Volck oil, 1 gallon and ½ pound Fluxit spreader in 100 gallons of water. This was applied in the calyx to all plots and in 4 cover sprays in the first plot, 5 in the second and 8 in the third. At harvest these plots showed 13 per cent, 4 per cent, and 4 per cent wormy apples respectively. In the first, which had 13 per cent wormy apples, no spray was applied after July 9, which undoubtedly accounts for the high percentage of worms. It was the only plot of the three, however, in which the oil-nicotine was compared with the regular arsenate of lead program. In this latter there were 21 per cent wormy apples at harvest time—an increase of almost 50 per cent over the oil-nicotine. The apples in these two blocks were graded commercially after being picked. The oil-nicotine block showed 27 per cent Extra Fancy, 38 per cent Fancy, and 18 per cent C grade, while the lead arsenate block packed 15 per cent Extra Fancy, 37 per cent Fancy, and 21 per cent C grade.

During the season of 1928 further and more extensive experiments were carried on looking towards the control of codling moth by means of nicotine, oil, and nicotine and oil combined. The plots were compared in each case with similar ones sprayed with the standard arsenate of lead treatment thruout the season. These were conducted in cooperation with the following: Dr. R. L. Webster and Prof. Anthony Spuler of the Washington State College and, thru Mr. F. E. DeSellem, with the Wenatchee District Cooperative Association, at Wenatchee, Washington; Mr. E. J. Newcomer, of the U. S. Bureau of Entomology, at Yakima, Washington; Prof. Leroy Childs. of the Hood River Branch Experiment Station at Hood River, Oregon; Prof. Claude Wakeland, of the University of Idaho; also with several carefully selected growers in the Wenatchee and Yakima Valleys in Washington.

In most of these experiments oil or nicotine alone were somewhat inferior to arsenate of lead in the control of codling moth. On the other hand the nicotine-oil combination gave, in general, control of worms comparable to that obtained with the lead arsenate and usually better control of "stings." In addition it was noted that with the oil-nicotine combination commercial control was usually obtained of several other apple insects such as red spider, San José scale and green aphis. Also

considerable reduction was observed in the amount of woolly aphis present in oil-nicotine sprayed plots and orchards. This is important since it has been quite definitely established that this insect is closely connected with the spread of the dreaded perennial canker.

It was often further noticed that along with the results in worm control additional commercial advantages from the use of oil-nicotine combinations have appeared in the nature of frequent increase in the size of the fruit and in raising the percentage of Extra Fancy and Fancy fruit. The amount of both fancy grades has been increased as high as 10 per cent in orchards sprayed with nicotine-oil in competition with the standard arsenate of lead program. The substitution of oil-nicotine for arsenate of lead in several of the cover sprays also enabled several growers to eliminate washing for removal of arsenical spray residue.

Because of the above mentioned results and the tendencies suggested by them, the interest of experimenters and of progressive growers has become focused on the more wide spread possible substitution of a combination of nicotine and oil in one or more of the cover sprays. In the past season's work this combination was used in either all of the cover sprays or at least commencing with the second. Altho all of the data on the past season's work is not yet fully tabulated and digested, it has seemed advisable here to present a very brief summary of such as have been completed and show comparable results. Our thanks are due to the earlier mentioned workers for permission to use figures collected for the most part by themselves.

In 12 out of 16 comparisons oil-nicotine gave better control than either arsenate of lead alone or oil and arsenate of lead combined. In these same 16 comparisons the average of worms and stings was 6.1 per cent while with the arsenate of lead or oil and lead the average was 8.9 per cent worms and stings. A number of other orchards showed very good control but the results are not included since there was no arsenate of lead sprayed fruit with which to compare it. In some other cases the percentage of worms was so small in either case that it did not seem worth while to make any counts.

This orchard had a calyx and one cover spray of arsenate of lead 2 pounds plus Fluxit ½ pound per 100 gallons of water throughout; the treatment indicated in the table being for the 2nd and 3rd cover sprays only. The 3rd and last cover was applied June 10th. Medol-L is a light type of highly refined summer oil manufactured by Balfour, Guthrie & Co. B. L. 40 stands for "Black Leaf 40." Fluxit is a casein spreader.

TABLE 1. WORM CONTROL ON THE C. R. VILLMANN RANCH, WAPATO, WASH.

Block No.	No. of Apples Counted	% Wormy	% Stung	% Total Fruit Wormy and Stung	Treatment (per 100 gals.)	
			JONATHANS			
I	6745	2.1	.9	3.0	Medol-L B. L. 40 Fluxit	½ gal. 1 pint ½ lb.
II	5742	3.1	.7	3.8	Medol-L B. L. 40 Fluxit	1 gal. ¾ pint ½ lb.
III	4615	7.3	3.1	10.4	Arsenate of lead Fluxit	2 lbs. ½ lb.
			ARKANSAS BLACKS			
I	7413	1.6	1.1	2.7	As block I above	
II	5942	4.8	3.5	8.3	As block II above	
III	6686	2.2	4.9	7.1	As block III above	
			WINESAPS			
I	6419	1.4	1.3	2.7	As block I above	
II	3979	3.3	3.1	6.4	As block II above	
III	5050	4.1	5.8	9.9	As block III above	

These plots are in an orchard which averaged 10 to 15 per cent wormy in 1927 but the part of the orchard in which this experiment was located ran almost 30 per cent wormy the same year.

Block 2 was nearer the farm buildings where culled apples had previously accumulated. This possibly accounts for the comparatively poor control of worms in the Arkansas Blacks.

The trees in both Blocks I and II were banded with tarred paper bands to which the worms were not readily attracted while Block III was banded with burlap under which the worms congregated freely. For the full season the following are the averages of worms collected under the bands:

TABLE 2. BANDING RECORDS ON THE C. R. VILLMANN RANCH, WAPATO, WASH.

Block No.	Average No. Worms per Tree
I	.05 Tarred paper bands
II	.10 " " "
III	2.70 Burlap bands

Had the same bands been applied on all blocks the results should have been still more in favor of the oil-nicotine combinations.

TABLE 3. FRUIT GRADES OF JONATHAN APPLES ON THE C. R. VILLMANN RANCH, WAPATO, WASH.

Block No.	Total Pkd. Boxes	% Extra Fancy	% Fancy	% C Grade	% Culls	Increase in X. F.'s & F.'s
I	1150	29.6	55.3	7.5	7.6	13.8
II	1153	28.8	52.8	10.9	7.5	10.5
III	1433	22.3	48.8	15.0	13.9	0

Block I consisted of 116 trees, Block II of 120 trees; Block III, is a part of the orchard adjacent to Blocks I and II. The greater production of boxes in Block III is due to a greater number of trees being used. The blocks were about four-fifths Jonathans; the remainder were Arkansas Blacks and Winesaps, on which it was not practicable to obtain the grades.

These grades and prices were given us by Mr. Villmann himself who packed his apples on the ranch. Although the percentages of the two higher grades seems rather low, they are actually considerably higher than the average for Jonathans throughout the Yakima Valley in 1928, the lowered percentage of grade being due mainly to frost, mildew and worms.

TABLE 4. INCOME FROM JONATHAN APPLES ON THE C. R. VILLMANN RANCH, WAPATO, WASH.

Block No.	Av. Price per Box	Boxes Produced per Tree	Value per Tree	Incr. Over Lead per Tree	Cost of Spray per Tree per Season	Net Inc. Over Lead per Tree
I	$.97	12	$11.64	$1.80	$.66	$1.40
II	.95	12	11.40	1.56	.64	1.18
III	.82	12	9.84	0	.26	0

The above prices include all grades and culls, the latter selling at $7 per ton. Everything is figured in packed boxes (1 bushel each) for convenience. The cost of the spray is figured on a basis of 17 gallons per tree application which is rather high, the Jonathan trees averaging much smaller than the other two varieties in these blocks.

The increases obtained of $1.18 and $1.40 net per tree would often mean a difference between profit and loss in many orchards. To this grower it would have meant an increased net income of $4,000 to $5,000 on his 80 acre orchard. The results indicate that the use of oil and nicotine is capable of being a paying investment instead of just an added expense as is thought by many growers.

TABLE 5. WORM CONTROL ON THE IRVING W. SMITH RANCH, ROCK ISLAND, WASH.

Block No.	No. Apples Counted	% Wormy	% Stung	% Total Wormy and Stung	Treatment per 100 Gallons
			DELICIOUS		
I	5839	1.6	.3	1.9	Nicona 1¼ gals.
II	8921	1.5	.7	2.2	Lead 2 lbs.
			WINESAPS		
I	5483	1.0	1.8	2.8	Nicona 1¼ gals.
II	4317	.3	2.1	2.4	Lead 2 lbs.

Both blocks received a calyx spray of arsenate of lead 2 pounds, and 4 cover sprays; block 1 had 2 pounds of arsenate of lead added to the first cover; block II had 1 gallon of summer oil added to the last cover. Fluxit ½ pound per 100 gallons was added to all the sprays. Nicona is a refined oil emulsion containing 1.25 per cent to 1.37 per cent free nicotine and is manufactured by Balfour, Guthrie & Company.

Block I was almost entirely free from red spiders, San José scale and aphis thruout the season. Block II had some San José scale, considerable woolly aphis, and was very badly infested with red spider until sprayed with oil in the last cover.

Growers often pick Delicious apples for color early in the season so as to get all they can in on an early market. On September 17th, Mr. Smith made his first picking and obtained about 12 loose boxes per tree, or about 75 per cent of the fruit from Block I and only 4 to 5 boxes per tree from Block II. Even those apples which were picked from Block II had less color and consequently a smaller percentage was packed as Extra Fancy. This was still true when the second and third pickings were made 8 and 12 days later. Block I was stripped in the second picking and Block II in the third picking.

Besides this increase in color there was also a corresponding increase in size. Block I averaged 71.2 apples per loose box and Block II averaged 86.2 or an increase in size of 21 per cent. This would amount to an increase of about 3.6 packed boxes per tree which can be very conservatively figured at $1 per box or an increase of $3.60 per tree in favor of the nicotine-oil spray.

After deducting the extra cost of the spray material, $.76, this would leave a net increase of $2.84 per tree, showing a handsome interest on the investment in the nicotine-oil in comparison with the arsenate of lead.

The increase in both color and size in this orchard were due chiefly to red spider control, a heavy infestation having prevented the leaves from functioning normally. Even without this difference in size, however, it was estimated by the grower that the oil-nicotine spray paid for itself in controlling San José scale, and woolly aphis in his orchard.

The available data on the oil-nicotine plots in Washington State College—Wenatchee District Traffic Association Experiment, at Wenatchee, Wash., 1928, may be very briefly summarized as follows:

TABLE 6.

Plot No.	Treatment	% Wormy	% Stung	% Tot Wormy & Stung	Variety
T-5	Lead Ars. in calyx & 1st cover; 1% oil+ B. L. 40, 1–800 in 2nd–5th covers.	1.9	4.7	6.6	Rome
B-3	Lead Ars. in calyx; ½% Oronite Technical oil+ B. L. 40, 1–800, in 1st–5th covers.	.6	2.0	2.6	Delicious
B-3	As above	.6	2.2	2.8	Winesap
B-6	Lead Ars. in calyx; 1% Oronite Technical oil+B. L. 40, 1–800 in 1st–5th covers.	.4	2.2	2.6	Delicious
A-3	Lead Ars. 1–50 in calyx and 5 covers	.9	7.0	7.9	Delicious

The results on the two oil-nicotine plots compared with the two arsenate of lead plots and an unsprayed check in experiments conducted by Prof. Claude Wakeland at Parma, Idaho, 1928, are summarized as follows:

Plot No.	Treatment	% Wormy	% Stung	% Tot. Wormy & Stung
7	Lead Ars. 2 lbs. per 100 gals. in calyx and 5 covers.	3.9	16.7	20.6
8	Lead Ars. 3 lbs. per 100 gals. in calyx and 5 covers.	2.9	8.8	11.7
11	Lead Ars. in calyx and 1st cover; B. L. 40 1–800+ ¾% oil in 2nd to 5th covers.	4.6	3.5	8.1
12	Lead Ars. in calyx and 1st two covers; B. L. 40 1–800 ¾% oil in 3rd to 5th covers	7.9	7.6	15.5
14	Unsprayed check	77.5	2.2	79.7

The variety is Winesap. The calyx spray in the above was made May 9–10; first cover, May 18–19; second cover, May 31; third cover, June 19; fourth cover, July 10; fifth cover, July 25.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by W. B. Herms.

A FIELD TEST OF THE EFFECT OF ARTIFICIAL LIGHT ON THE BEHAVIOR OF THE CODLING MOTH *CARPOCAPSA POMONELLA* LINN.

By W. B. HERMS, *University of California, Berkeley, Calif.*

ABSTRACT

Six 500-watt lights were suspended directly over a block of fifteen trees consisting of several varieties of apples. The plot was flooded with light each evening for two and a half to three hours from April 26 to June 30, i. e., to the end of the first brood of codling moth. Temperature for the period was recorded and foot candle meter readings were made to ascertain light intensities. Comparing fruit of the same variety at the end of the test it was found that 21 per cent of the apples on check trees outside the test plot were moth attacked while only 14.5 per cent of the apples inside the test plot were so affected. Light of the intensity and quality used indicates a tendency to deter the codling moth in its egg laying habits.

Much has been written during the past score of years concerning the effect of light on insects and other animals, based largely on laboratory experimentation. While much if not nearly all of this experimentation has dealt with species of little or no economic importance, it has been of great value with respect to a fundamental knowledge of photic reactions and in the refinement of applicable apparatus and methods.

More than twenty years ago in an address (Herms[1] 1909) to growers and entomologists in one of California's greatest apple growing districts, the writer made a plea for a technical study of the behavior of important insect pests,—the codling moth was then under discussion. With no guarantee that any practical results would accrue even in the long run it is no reflection on the intelligence of the audience that only a respectful hearing was accorded the paper. However, ideas die hard. Almost exactly twenty years later with the organization of the California Committee on the Relation of Electricity to Agriculture, funds were placed at the disposal of the author to carry on such tests as might seem appropriate. The codling moth was chosen as one of our subjects and both laboratory and field experiments were planned using artificial light as the stimulus.

A field study of the egg-laying habits of the codling moth soon convinces one that this insect is powerfully governed by certain physical forces evidently light and temperature in particular. Slingerland[2] (1898) wrote, "Unlike many other moths, the codling moth is not attracted to lights. This has been demonstrated several times by careful experiments with trap-lanterns in orchards." Spuler[3] (1927) writes, "While the codling moth will fly to a window when confined in a dark room or will seek a dim light placed in a dark room in an effort to escape, bright lights placed out-of-doors in the natural habitat of the moth fail to attract them." Isely and Ackerman[4] (1923) state, "...the factor controlling the time of oviposition was not the time of day, but the relative degree of light or darkness.....At least partial darkness is necessary for heavy oviposition, and oviposition begins at a temperature above 62° F."

[1]Herms, W. B. 1909. Recent work in insect behavior and its economic significance. Journ. Econ. Entom., Vol. 2, No. 3, pp. 223–230.

[2]Slingerland, M. V. 1898. The codling-moth. Cornell Univ. Agric. Exp. Sta. Bul. No. 142.

[3]Spuler, Anthony. 1927. Codling moth traps. State Coll. of Wash., Agric. Exp. Sta. Bul. No. 214.

[4]Isley, D. and Ackerman, A. J. 1923. Life History of the codling moth in Arkansas. Univ. of Ark. Agric. Exp. Sta. Bul. 189.

The most recent contribution to this subject is made by Peterson and Haeussler[5] (1928), who write viz: "It is a well known fact that oriental peach moths, *Laspeyresia molesta* Busck, and codling moths, *Laspeyresia pomonella* L., congregate on the light side of screen cages or glass containers, consequently it may be assumed that the adults of both species under certain conditions are positively phototropic."

Assuming that light and temperature are the governing factors in the egg laying function of the codling moth, one might raise the question, "Is it practicable to control one or the other or both of these factors in the field?" Even though the expense might be considerable, if successful it might be even less than the cost of spraying, and, in addition the fruit would be free from arsenical residues, an achievement worth striving for.

To maintain an orchard temperature below 60° F. during the period of oviposition would appear to be impossible or at least impracticable, and in addition undesirable, but to produce and maintain a light of sufficient intensity during this period to *deter* the codling moth in the performance of this function does not seem entirely out of reason. Field tests on a large scale to attract other moths have been made, one of these is cited by Peterson and Haeussler (loc. cit.), viz: 25-watt lights over pans with oil were placed in an orchard with the object of controlling the oriental peach moth, *Laspeyresia molesta;* few moths were caught in the pans, no success being achieved.

Material and Method

A block of fifteen trees (three rows of five trees each), Table 1, in a heavily infested area was selected in an apple orchard of mixed varieties at Graton (Sonoma County), California. Except for the dormant lime-sulfur winter treatment these trees remained unsprayed. Sprayed and unsprayed check trees of the same varieties as those in the lighted area were situated at various distances from the lights. The trees sprayed for codling moth received the usual calyx and first cover spray of lead arsenate, 3 pounds to the 100 gallons of water. Six 500-watt Mazda lights, each with a large white enamel reflector were suspended at an elevation of about 20 feet from the ground, i.e., just over the topmost branches of the trees in the plot. The lights were turned on and off by means of a hand switch from April 26, when the test began, to May 31 and from that time to June 30, the end of the test (i.e., the end of first

[5]Peterson, Alvah, and Haeussler, G. J. 1928. Response of the oriental peach moth and codling moth to colored lights. Ann. Entom. Soc. Amer., Vol. XXI, No. 3, pp. 353–374.

TABLE 1. SHOWING LOCATIONS OF TREES USED IN LIGHT EXPERIMENT. TREES NUMBERED 1 TO 15 INCL. IN LIGHT AREA; 16 TO 35 CHECK TREES OUTSIDE OF LIGHT AREA; O INDICATES LOCATIONS OF 500 WATT ELECTRIC LIGHTS; s INDICATES TREES WERE SPRAYED; 1, 2, etc. INDICATES LOCATION OF BAIT PANS; FOR VARIETIES OF APPLE SEE TABLE 2; P, PEACH TREES. ALL TREES INDICATED BY x WERE SPRAYED.

Private Road (North End)

Private Road (West Side)

x	x	x	1	6	11	x	x	x	x	x	x	x	x	x
				O	O									
x1	x	x	2	7	12	x	x	P	P	P	x	x	x	x
x	P	P	3	O	8_9	o	13_8	23	24	25	P	–	x	x	31_7	32
														s	s	
x	33	x	4	9	14	x	x	x	x	P	P	x	P	x	x	
	s			O	O											
x	x	–	5	10	15	x	26_5	x	x	–	x	x	x	x		
x	x	x	x	P	x	x	x	x	x	–	x	x	x	x		
x2	x	x	x	16	P	–	27	x	–	x	x	x	x	x		
							s									
x	x	x	x	17	–	x	28	x	x	x	x	–	x	29_6		
							s							s		
x	x	x	x3	18	x	x	–	–	x	x	x	x	x	30		
														s		
x	34	x	x	19	x	x	x	x	x	x	x	x	x	x		
x	35	x	x	x	x	x	x	x	x	x	x	x	x	x		
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
x	x	x	x	20	x	x	x	x	x	x	x	x	x	x		
x	x	x	22	21	–	x	x	x	x	x	x	x	x	x		
x	x	x	x4	x	x	x	x	x	x	x	x	x	x	x		
x	x	x	x	–	x	–	x10	x	x	x	x	x	x	x		

brood of moths) by means of an automatic control switch. The artificial illumination was applied for a period of two and a half to three hours each evening, i.e. from about half an hour before sunset to about two hours after sunset. The temperature records were kept by means of a registered thermometer and a recording thermograph. Light intensities were measured in foot candles by means of a General Electric

portable foot candle-meter. Measurements were made at various times to test the light intensities, both within and without the lighted area. Molasses bait traps renewed about every five days were used to check the emergence of the moths. The bait used consisted of one part molasses and nine parts of water, to which was added a yeast cake to a gallon of the mixture. Traps consisting of shallow white enamel pans with bait were suspended in certain trees in the lighted area and also in other parts of the plot (See Table 1). At the conclusion of the test, June 30, a count was made of moth damaged apples on the tree, one hundred to a tree[6] (or as indicated in Table 2), only definite entrance or exit markings were counted, miniature stings being omitted.

TABLE 2. SHOWING PERCENTAGE OF MOTH DAMAGED APPLES ON TREE, BASED ON COUNTS OF 100 APPLES PER TREE, MADE JUNE 30, 1928 (END OF FIRST BROOD). COUNTS IN LIGHTED AREA WERE TAKEN ON EAST AND WEST SIDES OF TREES, WHILE THOSE OUTSIDE OF THIS AREA WERE MADE ON THE NORTH SIDE. THIS TABLE SHOULD BE COMPARED WITH TABLE 1 WHICH SHOWS LOCATIONS OF TREES IN THE EXPERIMENTAL PLOT, HALLBERG ORCHARD, GRATON, CALIF.

Tree No.	Side of Tree	Apples Counted	Damaged %	Sprayed	Bait Trap No.	Variety
*1	East ½	100	21	No	..	Ben Davis
*1	West ½	100	14	No	..	Ben Davis
*2	East ½	100	18	No	..	Ben Davis
*2	West ½	100	8	No	..	Ben Davis
*3	East ½	100	4	No	..	Hoover
*4	....	Non-bearing	..	...	..	Newtown Pippin
*5	East ½	100	28	No	..	Ben Davis
*6	West ½	100	15	No	..	Skinner Pippin
*7	West ½	100	15	No	..	Ben Davis
*8	West ½	100	9	No	9	Skinner Pippin
*9	West ½	100	19	No	..	Ben Davis
*9	East ½	100	17	No	..	Ben Davis
*10	West ½	60	48	No	..	Baldwin
*11	West ½	100	15	No	..	Skinner Pippin
*12	West ½	100	2	No	..	Wagner
*13	West ½	80	20	No	8	Skinner Pippin
*14	....	Non-bearing	..	...	..	Skinner Pippin
*15	....	Non-bearing	..	...	..	Baldwin
16	North ½	100	22	No	..	Skinner Pippin
17	North ½	100	16	No	..	Skinner Pippin
18	North ½	80	19	No	..	Skinner Pippin
19	North ½	100	13	No	..	Skinner Pippin
20	North ½	100	31	No	..	Skinner Pippin
21	North ½	100	29	No	..	Newtown Pippin

[6]There were no windfalls at that time.

TABLE 2—*Cont.*

Tree No.	Side of Tree	Apples Counted	Damaged %	Sprayed	Bait Trap No.	Variety
22	North ½	100	25	No	..	Skinner Pippin
23	West ½	100	6	No	..	Wagner
24	West ½	100	2	No	..	Wagner
25 .	West ½	100	0	No	..	Wagner
26	West ½	100	6	No	5	Bellflower
26	East ½	100	5	No	5	Bellflower
27	West ½	100	2	Yes	..	Bellflower
27	East ½	100	3	Yes	..	Bellflower
28	West ½	100	1	No	..	Bellflower
28	East ½	100	8	No	..	Bellflower
29	West ½	100	1	Yes	6	Bellflower
29	East ½	100	1	Yes	..	Bellflower
30	West ½	100	3	Yes	..	Bellflower
30	East ½	100	6	Yes	..	Bellflower
31	West ½	100	1	Yes	7	Bellflower
31	East ½	100	3	Yes	7	Bellflower
32	West ½	100	1	Yes	..	Bellflower
32	East ½	100	3	Yes	..	Bellflower
33	West ½	100	2	Yes	..	Bellflower
33	East ½	100	0	Yes	..	Bellflower
34	East ½	100	0	No	..	Wagner
35	East ½	100	1	Yes	..	Wagner

*Within the lighted area.

Because of his long experience with the codling moth, Mr. A. D. Boren, Research Assistant in Entomology and Parasitology, was particularly well qualified to make the necessary critical field observations and to generally conduct the test. The installation of the lighting system was supervised by Prof. B. D. Moses of the Division of Agricultural Engineering and Mr. J. R. Tavernetti, Field Engineer of the California Committee on the Relation of Electricity to Agriculture. To Mr. A. Hallberg, owner of the orchard, our thanks are particularly due.

TABLE 3.—SHOWING LIGHTING SCHEDULE FOR THE PERIOD OF THE TEST, ALSO RECORD OF TEMPERATURE IN F. AT TIME LIGHTS WENT ON AND OFF. THE NUMBER OF MOTHS TAKEN IN BAIT TRAPS IS ALSO SHOWN.

Date	Lights on Time (P.M.)	Lights on Temp. (F.)	Lights off Time (P.M.)	Lights off Temp. (F.)	Total No. Moths Taken in Traps	Moths Taken in Individual Traps (See Table 1 for Locations) 1	2	3	4	5	6	7	8	9	10
1928															
April 26	6:00	60	9:00	54	...										
27	6:30	62	9:45	56	28	4	0	7	6	0	2	3	3	2	1
28	6:15	65	9:15	60	168	16	9	14	11	36	13	19	23	16	11
29	6:15	66	9:30	54	130	16	4	8	20	19	14	21	14	3	11
30	6:00	61	8:30	56	100	6	5	7	6	14	18	12	9	14	9

TABLE 3—*Cont.*

Date	Lights on Time (P.M.)	Lights on Temp. (F.)	Lights off Time (P.M.)	Lights off Temp. (F.)	Total No. Moths Taken in Traps	Moths Taken in Individual Traps (See Table 1 for Locations) 1	2	3	4	5	6	7	8	9	10
1928															
May 1	6:15	61.5	8:45	54	15	1	0	4	3	0	3	1	3	0	0
2	6:45	60	8:30	54	...	No collection									
3	6:30	60.5	8:30	53	...	No collection									
4	6:30	67	9:30	52.5	(3 ds.)										
					189	12	8	18	10	13	27	35	21	13	32
5	6:15	67	9:50	50	41	6	2	2	5	3	3	3	3	6	8
6	6:30	58	8:10	56	28	3	0	3	2	1	2	3	2	3	9
7	6:30	60	9:45	54	17	1	0	3	2	2	4	3	1	0	1
8	6:20	61	9:00	56	5	1	0	1	1	0	1	1	0	0	0
9	6:30	54	8:00	50	3	0	0	0	0	0	1	1	0	1	0
10	6:30	56	8:30	54	1	0	0	1	0	0	0	0	0	0	0
11	6:30	64	8:30	55	3	0	0	0	0	2	1	0	0	0	0
12	6:30	67	8:30	55	...	No collection									
13	6:15	56	9:45	50	...	No collection									
14	6:30	57	8:40	51	...	No collection									
15	6:00	62	8:45	55	(4 ds.)										
					11	0	0	1	2	2	4	0	2	0	0
16	6:10	60	9:00	52	...	No collection									
17	6:00	60	8:40	52	...	No collection									
18	6:00	62	9:00	53	...	No collection									
19	6:10	62	9:10	52	...	No collection									
20	6:15	63	9:30	54	...	No collection									
21	6:10	62	8:50	54	(6 ds.)										
					2	0	0	1	1	0	0	0	0	0	0
22	6:00	80	9:20	62	...	No collection									
23	6:05	74	9:00	60	...	No collection									
24	6:00	72	9:05	56	...	No collection									
25	6:10	68	8:40	55	(4 ds.)										
					8	1	0	2	0	0	4	1	0	0	0
26	6:05	80	9:20	66	...	No collection									
27	6:00	73	9:00	60	...	No collection									
28	6:10	80	9:10	62	(3 ds.)										
					1	0	0	0	0	0	1	0	0	0	0
29	6:00	74	9:00	64	...	No collection									
30	6:10	80	9:20	60	...	No collection									
31	6:10	70	9:00	56	(3 ds.)										
					11	0	1	1	0	1	4	2	2	0	0
June 1–15	6:30	..	8:30	..	(15 ds.)										
					109	9	7	3	4	15	16	18	18	6	13
15–30	6:45	..	9:00	..	(15 ds.)										
					42	0	1	7	7	7	6	3	3	2	6
					Total 912	76	37	83	80	115	124	126	104	66	101

The Light Intensity

An examination of Table 4 will show that the natural light intensity at sunset was 4 foot candles, diminishing rapidly to the point where it could not be measured (.000) by means of the foot candle meter. It is of interest to note that the light intensity within the lighted area under lights as shown by the same table was artificially maintained at 4.0 foot candles (readings made directly under light west of trees 9 and 10)

Table 4. Showing Light Intensities in Various Parts of the Orchard. The Readings Were Made by Means of a General Electric Foot Candle Meter. The Following Readings Were Made April 30 and Repeated Several Times at Intervals of Several Days. Time Consumed to go From One Location to Another Required Not Over One Minute, Requiring But a Slight Correction in Time Recorded.

Time	Location	Foot Candles
7:00 P. M.	Natural conditions	10.0
7:15 P. M.	" "	4.0 sunset
7:30 P. M.	" "	.3
7:45 P. M.	" "	.025
8:00 P. M.	" "	.000
7:00 P. M.	Under lights	11.0
7:15 P. M.	" "	10.0
7:30 P. M'	" "	4.5
7:45 P. M.	" "	4.0
8:00 P. M.	" "	4.0
8:15 P. M.	" "	4.0
8:30 P. M.	" "	4.0
7:15 P. M.	Third row east	.35
7:30 P. M.	" " "	.4
7:45 P, M.	" " "	.4
8:00 P. M.	" " "	.4
8:15 P. M.	" " "	.3
8:30 P. M.	" " "	.3
7:30 P. M.	Fifth row east	.25
7:45 P. M.	" " "	.13
8:00 P. M.	" " "	.14
8:15 P. M.	" " "	.13
8:30 P. M.	" " "	.12

throughout the period of artificial illumination. If this sunset light intensity favors the codling moth in its egg laying habits, then it would appear that this favorable intensity was greatly extended artificially within the lighted plot, i.e., daily throughout each evening, and there should have been more moth damaged apples within the lighted area than outside of it. As a matter of fact comparing like varieties of apples there was a larger percentage of damaged apples (see Table 2) on

those trees outside the more intensely lighted plot where the light intensity during artificial illumination measured from .3 to .4 foot candle, i.e., the light intensity at about fifteen minutes after sunset.

Moths Trapped

The total number of codling moths trapped in the ten bait pans during the test was 912, an average of 91.2 per pan (Table 3). Traps Nos. 6 and 7 showed the largest number trapped, i.e., 124 and 126 respectively, an average of 125 per pan. These two traps were at the edge of the orchard well removed from the influence of the lights. Traps Nos. 8 and 9 were in the artificially illuminated plot and gave a total of 66 and 104 respectively, an average of 85.

The four traps (Nos. 4, 6, 7 and 10) farthest away from the lights showed an average of 108 moths trapped, the four (Nos. 1, 2, 3 and 5) nearer the lighted plot but not inside showed an average of 77 moths and the two traps inside the plot (Nos. 8 and 9) gave an average of 85. Bait pan No. 3, located close to the trees where the largest percentage of damaged apples was found trapped 83 moths, less than the general average for all the pans. This may have been due to some fault in the location of the pan among the branches of the tree.

Discussion

A general view of the situation, i.e., locations of trees, lights and bait traps, is presented in Table 1. The variety of the trees is shown in Table 2. The light intensity in various parts of the orchard during the evening is shown in Table 4 and moths collected in bait pans are shown in Table 3.

Of the trees in the lighted plot, Nos. 1 to 15 inclusive, four are Skinner Pippins, trees Nos. 6, 8, 11 and 13 which may be compared with trees Nos. 16, 17, 18, 19, 20 and 22 of the same variety outside the plot,—both groups unsprayed. The former group received an illumination during the early evening hours of about 4 foot candles while the latter group received an illumination of only about .3 to .4 foot candles during the same time (i.e., using the same readings taken 3 rows east). Table 4. The percentage of moth damaged apples on the trees in the first group was 14.5 per cent ($15 + 9 + 15 + 16 = 55$ apples out of 380), while there were 21 per cent damaged apples in the second group ($22 + 16 + 15 + 13 + 31 + 25 = 122$ out of 580). If all of the trees of all varieties (except Wagners and Bellflowers which showed a very low percentage of moth attack whether sprayed or unsprayed) both inside the lighted test plot and outside are taken into account, there still remains

about the same proportion, i.e., 15.8. per cent inside the plot (21 + 14 + 18 + 8 + 4 + 28 + 15 + 15 + 9 + 19 + 17 + 28 + 15 + 16 = 227 out of 1440 apples) and 22.2 per cent outside (22 + 16 + 15 + 13 + 31 + 29 + 25 = 151 out of 680 apples).

Conclusions

1. Comparing only fruit of the same variety (Skinner Pippins) fewer apples were affected by the codling moth in the more intensely (about 4 foot candles) artificially illuminated test plot than outside of it, i.e., 14.5 per cent inside and 21 per cent outside.

2. The highest percentage of moth attacked apples appeared to occur in that portion of the orchard where the light intensity by artificial illumination remained for the evening at from .3 to .4 foot candles, i.e., the intensity of natural light shortly after sunset.

3. The smaller percentage of damaged apples in the more intensely illuminated area seems to indicate that light of the intensity and quality used has a tendency to deter the codling moth in its egg laying habits.

4. Sufficiently definite results have been achieved in this test to warrant a continuation of this investigation on a larger scale, using lights of both different intensity and quality.

Mr. F. E. Guyton: I wonder why the investigator used the light at such early hours in the evening.

President W. B. Herms: The temperature conditions are one thing and matters of convenience were other governing factors. This was just a test which next year will be carried on a very much more scientific basis, I hope, than the test was carried on during this past summer. It was a sort of preliminary report.

Mr. F. E. Guyton: It might be interesting for you to know light traps have been used in control of the tomato fruit worm by two commercial gardeners in Alabama, in one case for two years, and in another, one year. Both gardeners report good control. The lights were burned throughout the night.

Mr. E. A. Siegler: The Bureau's experiments have shown, as a rule, the codling moth doesn't oviposit after nine o'clock at night, so there would be no object in carrying the light for a longer period.

President W. B. Herms: That is true, too.

Mr. P. J. Parrott: We have been carrying on experiments somewhat like those of Dr. Herms' except that we have had electrocuting attachments to the lights and we have been trying to interpret the results of our experiments through the number of moths killed as well as by the results on the fruit. It is very hard to interpret data that we have

satisfactorily. We have had two orchards which have received illumination continuously through the night all through the growing period.

Some strange things seem to happen with both bait traps and electric lights. Some nights we kill more moths with the electric traps and other nights the bait pails catch more moths, but taking the total number trapped by bait pails or killed by the electric lights, the number obtained seems to be very small as compared with the number that must be in the orchard as judged by the injury to the fruit in the check plots.

In counting our fruits, we find that the trees that have received illumination continuously through the night throughout the entire growing period are somewhat better than the checks, but markedly inferior to those that have been sprayed.

Another interesting problem in connection with light has been brought to my attention; in one of our leading apple growing areas at Hilton we carried on an extensive experiment with lights against the apple tree leaf roller and the bud moth. In the case of the leaf roller, we caught this year approximately 40,000 moths and in the case of the bud moth over 60,000. In the case of the bud moth, we tried to estimate the benefit derived by lights by counting the number of larvae and measuring the extent of feeding on the leaves. Remember in this connection that we have a summer brood of bud moths. Supposing now we were catching a lot of moths, we ought to be able to measure the benefit derived from the number caught by the extent of feeding of the caterpillars on the foliage. We have counted about 20,000 and examined them carefully. There again we are able to see that a slight benefit has been derived, but not large, certainly a benefit that does not compare for a moment with that obtained by spraying.

Here is the puzzling feature. You would think that capturing as many as 60,000 moths ought to be attended with some benefit, and it has, but not much. Now, then, have our captures been limited to moths produced in the orchard, or have we got to take into consideration drifts of moths from adjoining orchards? If we are capturing moths from other orchards, then certainly in the case of our experiments we have got to extend the radius of our operations of light.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by T. J. Headlee.

AN OPERATION IN PRACTICAL CONTROL OF CODLING MOTH IN A HEAVILY INFESTED DISTRICT— THIRD AND FINAL REPORT[1]

By THOMAS J. HEADLEE, Ph.D., *Entomologist,*
New Jersey Agricultural Experiment Station

ABSTRACT

This paper reviews the results of a three year cooperative effort against the codling moth, *Carpocapsa pomonella*, in a heavily infested district near Glassboro, New Jersey. This cooperation existed between a group of more than twelve growers, whose properties involved a total of over 1400 acres of bearing apple, and the New Jersey Agricultural Experiment Station. In 1925, which is the year previous to the inception of this effort, the average percentage of fruit free from codling moth at picking time was 47.4. In 1926 the average clean fruit at picking time in a crop of 280,200 bushels was 68.8%. In 1927 the average clean fruit at picking time in a crop of 378,554 bushels was 80.8%. In 1928 the average clean fruit in a crop of 309,499 bushels was 81.1%. Of course there were individuals, and large producers too, that reached more than 95% clean fruit but there were others that were not as successful and the average consequently stood at the point mentioned. The small increase in average clean fruit at picking time in 1928 may be attributed mainly to the fear of arsenical residue.

This paper shows that in a cultivated orchard 91% of the overwintering generation of codling moths comes from the trunk and larger branches in the region covered by rough bark, 9% from the branches and twigs above the rough bark, and nothing from the ground under the tree. This paper shows that application of proper amounts of miscible pine oil to the rough bark portions of the tree results in destruction of all codling moth larvae wintering therein without apparent injury to the trees.

INTRODUCTION

As set forth in the first report on this subject this effort against the codling moth was cooperative in nature; a cooperation between certain apple growers and the Entomologist of the New Jersey Agricultural Experiment Station. According to the terms of the agreement the Entomologist was to specify the materials to be used, the methods of application of the said materials, and the time when they should be applied, while the growers were to purchase the materials and to make the applications in the manner and at the time specified. This cooperation was to cover a period of three seasons—1926, 1927 and 1928.

The occasion for this cooperation was the inability on the part of the growers to protect their fruit against the codling moth. The occasion for the presentation of this and the preceding two reports is found in the

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

fact that in some other parts of the United States growers have been likewise unable to control the codling moth in a satisfactory manner.

Factors Involved in the Control of the Codling Moth As Experience of the Three Years Has Revealed Them

Application of Insecticides. Without doubt the dominant factor in obtaining control of codling moth has been the application of the proper materials in the proper way at the proper time.

The insecticide employed has been lead arsenate applied at blossom fall and during the period of entry by larvae of the first and of the second broods. The application of lead arsenate at the blossom fall has shown no new principles and its efficiency in preventing blossom end worminess has been most excellent; only the barest fraction of 1% of the fruit showing any blossom end worminess whatever. The application of lead arsenate during the period of entry by first and second brood has disclosed seven facts of importance:

1. Film coatings are far more efficient than spot coatings;
2. Film coating maintained throughout the period of entry by first brood larvae is a matter of prime importance in obtaining satisfactory control;
3. Film coatings during the period of entry by second brood can, at best, reduce injury by a relatively small per cent;
4. Even split applications of arsenical dusts are only about half as efficient as liquid suspensions of lead arsenate;
5. The amount of arsenic deposited upon the fruit and the foliage in the form of film coating is much more important than the amount of arsenic used per gallons of spray water;
6. From eight to ten gallons of liquid spray containing powdered lead arsenate at the rate of four pounds to one hundred gallons appears in general to give an optimum arsenical charge to the fruit and foliage of a tree twenty-five feet high by thirty feet wide;
7. Spreaders and stickers of a casein nature (at least 25%) at the rate of three pounds to one hundred gallons of spray water appeared to give an optimum film coating.

Methods of Application. The method of application was specified by saying;

1. Place the spray in the outer calyx cup at the blossom fall;
2. By whatever method seems most practical establish a film coating of fruit and foliage as the first cover spray for codling moth and main-

tain the coating thus established throughout the period of entry by first brood larvae;

3. Where deemed necessary establish a film coating of fruit and foliage as the first cover spray against second brood larvae and maintain the coating thus established by one or more repetitions as the degree of infestation seems to demand.

To accomplish these results the growers employed many different methods more or less well adapted to the conditions under which they had to work. Some made applications entirely from the ground and others from the ground and from the tank. One grower would be very successful with one method while another grower would fail to obtain the objective with the same method. The objective, therefore, was the only thing in the method of application that could be specified and the detailed method of reaching that objective had to be left to the grower. In general the cleanest fruit occurred in the lower two-thirds of the tree. Apples in this zone were cleanest when inside the foliage wall. The most heavily infested portion of the tree in most orchards was the upper one-third, yet there were cases in which the top was just as clean as any other part of the tree and all were remarkably clean. Those growers who followed their spraying crews, climbed the trees and saw for themselves what kind of coating was being obtained, were the ones that obtained the best coatings, and were the ones that obtained the highest percentage of clean fruit.

Timing of Application. The timing of the blossom fall application was easy and more or less automatic because the development of the trees determined the time of application. The time of application for the first cover spray for the first brood larvae was made on the basis of the emergence of the overwintering generation. When one-half of the overwintering generation of moths had emerged the application of the first cover spray was called for. Repetitions of this cover spray were called for as soon as the film coating, established by the first, showed clear evidences of breaking through the effect of weathering. Time when spraying for the first brood could safely cease was determined as the time when the last moths of the overwintering generation had emerged. The time for the first cover spray for second brood larvae was determined as the date about one week previous to the time when one-half of the moths of the first summer generation had emerged and repetitions for the maintenance of the coating thus established were called for when clear evidences of the breaking of the film made their appearance. In the latter part of this work the strongest emphasis was placed

upon maintaining the film coating from its establishment throughout the period of entry by first brood larvae.

SPRAY RESIDUES. This intensive use of lead arsenate for codling moth control established spray residues upon the fruit to such an extent that their removal became in many cases necessary before it could be marketed. In 1928 the fear of spray residues influenced the intensity of the treatments for the first brood larvae and even more extensively influenced the treatment for second brood larvae. Arsenical dusts were resorted to in fighting second brood larvae and the writer thinks that these conditions were primarily responsible for the failure to obtain an additional eight or ten per cent increase in the average clean fruit in the season of 1928.

ORCHARD SANITATION. Under this head is included the prevention of the escape of the overwintered generation emerging from fruit containers into the orchards. In general, this matter was pretty well cared for in 1927 and excellently cared for in 1928.

Under the head of orchard sanitation is included also the use of codling moth bands. This was almost universally practiced wherever needed and in some cases where it was not required and played a minor but important part in the effort. The writer has not been in close contact with the efficiency of the narrow corrugated paper band as compared with broad folded six inch wide burlap band.

RESULTS. In the following Tables, 1 and 2, are set forth the results (Table 1) of the 1928 work in the form of clean fruit and the results (Table 2) of the whole three years effort.

Examination of the above tables and particularly Table 2 serves to show that a three year effort has resulted in more than 30% increase in fruit free from all codling moth injury at the time of picking of which the largest increase took place during the first year, next to the largest during the second year, and the smallest during the third year. Examination of the above tables also shows that there has been a decided increase in the total volume of fruit indicating clearly that the general orchard practice of the growers in the cooperative effort has been materially improved. 1926 was a low price year but 1927 was a high price year and 1928 promises likewise to be a high price year. The financial return to the grower for this effort has, therefore, been decidedly good.

SOME OUTSTANDING INDICATIONS FROM THIS WORK. Probably the most outstanding indication relative to the future practice which may be drawn from this work is that by the use of known measures of codling

TABLE 1. RESULTS OF THE COOPERATIVE WORK AGAINST THE CODLING MOTH IN THE GLASSBORO DISTRICT DURING 1928

Name of Owner	Number of Orchard	Early			Late			Total		
		Total	Clean	%	Total	Clean	%	Total	Clean	%
Del Sea	1	7,469	7,170.24	96	51,454	36,017.8	70	58,923	43,188.04	73.29
Kandle	2A				5,675	4,369.75	77	5,675	4,369.75	77
Kandle	2	800	696.0	87	2,312	439.28	19	3,112	1,135.28	36.48
Repp Co	3	1,000	860.0	86	52,542	37,304.82	71	53,542	38,164.82	71.27
Chas. Repp	3A				10,395	7,276.50	70	10,395	7,276.50	70
Ralph Mecouch	4	300	240	80	8,150	5,134.50	63	8,450	5,374.50	63.6
Wm. Davis	5				3,000	2,880.0	96	3,000	2,880.00	96
B. Heritage	6	1,850	1,822.25	98.5	17,450	15,530.5	89	19,300	17,352.75	89.9
Wm. Jones	7				3,814	3,623.3	95	3,814	3,623.3	95
N. J. Fruit	8	15,153	14,849.94	98	36,473	32,825.70	90	51,626	47,675.64	92.3
W. Brown	9	900	828.0	92	13,700	11,919.0	87	14,600	12,747.00	80.3
R. Allen	10 & 10A	14,319	13,746.29	96	30,083	28,879.68	96	44,402	42,625.97	96
L. T. Hallock	11					FROST				
A. Repp	12	2,000	1,640.0	82	9,600	6,336.0	66	11,600	7,976.0	68.7
A. Repp	12A	3,200	3,136.0	98	8,460	7,783.2	92	11,660	10,919.20	93.6
Wm. Evans	13	350	336.0	96	9,050	5,430.0	60	9,400	5,766.0	61.3
Totals		47,341	45,324.72	95.7	262,158	205,750.03	78.4	309,499	251,074.75	81.1

TABLE 2. RESULTS OF THREE YEARS COOPERATIVE WORK AGAINST THE CODLING MOTH IN THE GLASSBORO DISTRICT—A SUMMARY

Name of Orchard Owner	Orchard Number	Acreage	Number of Tree	Size of Tree	Codling Moth at Beginning and During Three Years of Work Against It: 1925 % Free	1926 Total Yield	1926 % Free	1927 Total Yield	1927 % Free	1928 Total Yield	1928 % Free
Del Sea	1	80	2,400	20x25	50	28,000	75	47,764	75.7	58,923	73.29
Del Sea	1A	130	7,000	20x25	55	13,000	50				
J. V. Kandle	2	25	700	25x30	25	6,000	40	3,400	70	3,112	36.48
J. V. Kandle	2A	25	700	12x14	40	4,000	85	7,450	90.2	5,675	77.0
Repp Co	3	100	5,000	20x25	45	65,000	60	40,390	68.4	53,542	71.27
Chas. Repp	3A	30	1,500	20x25	50	15,000	75	10,963	64.9	10,395	70.0
Chas. Repp	3B	15	800	25x30	00	5,000	85				
Ralph Mecouch	4	35	2,000	16x18	40	6,000	70	7,850	16.0	8,450	63.6
Wm. Davis	5	15	1,200	12x14	45	4,000	85	6,310	93.5	3,000	96.0
B. Heritage	6	60	3,000	20x25	60	12,000	85	18,550	88.1	19,300	89.9
Wm. Jones	7	15	900	16x20	60	3,200	90	3,063	88.0	3,814	95.0
N. J. Fruit et al	8	400	15,000	20x25	35	55,000	50	83,308	83.4	51,626	92.0
W. Brown	9	80	3,850	20x25	39	14,000	75	34,840	82.8	14,600	80.3
R. Allen No. 1	10	40	1,800	22x28	75	10,000	80	16,406	86.8	44,402	96.0
R. Allen No. 2	10A	50	3,000	25x30	80	23,000	95	27,085	95.9		
L. T. Hallock	11	276	25,000	10x12	60	17,000	97	35,900	95.2	no crop	
A. Repp	12	25	750	20x25	Entered 1927			11,768	56.3	11,600	66.7
A. Repp	12A	20	800	12x14	Entered 1927			4,947	85.6	11,660	93.6
Wm. Evans	13	30	800	25x30	Entered 1927		60	18,560	85.8	9,400	61.3
Totals	1376-1451		73,850 to 76,200		47.4	280,200	68.8	378,554	80.8	309,499	81.1

moth control that insect can be brought under a high degree of control even where parasites are so small as to be negligible in their effect. The second outstanding indication relative to future work is that considerable time is required to effect this result. This is due to the relatively slow diminution intensity of codling moth population and is to be met only by some method which will promptly destroy 90% or more of the overwintering larvae from which the overwintering generation of moths arise in the spring.

With this in mind an attempt was made to obtain the facts concerning the sources of the overwintering generation of moths. Two rather large trees in an orchard, which in 1927 had only 16% clean fruit at picking time, were caged in the season of 1928. Each cage was divided into three chambers. One was designated as the "top" and included all those parts of the tree above the rough bark. The second was called the "trunk" and included all those parts of the tree from the ground to the upper limit of the rough bark. The third was called the "bottom" and included the soil covered by the spread of the tree's branches. Both of these trees were in a cultivated orchard having a rather sandy soil. Cages were established before the moths began to emerge and were examined at regular intervals, every moth emerging being caught. Table 3, which follows, gives the results.

TABLE 3. SOURCES OF CODLING MOTH ADULTS (OVERWINTERED GENERATION) UNDER COMMERCIAL ORCHARD CONDITIONS

Date of	Moths Caught						
	Cage No. 1			Cage No. 2			Total
Examination	Top	Bottom	Trunk	Top	Bottom	Trunk	
5/25, '28	2	0	2	0	0	4	8
5/28, '28	1	0	4	1	0	5	11
6/1, '28	0	0	4	1	0	5	10
6/5, '28	2	0	9	0	0	6	17
6/8, '28	0	0	5	0	0	4	9
6/11, '28	0	0	6	0	0	3	9
6/15, '28	0	0	4	0	0	3	7
6/19, '28	0	0	3	0	0	0	3
6/22, '28	0	0	1	0	0	0	1
6/27, '28	0	0	2	0	0	0	2
6/29, '28	0	0	0	0	0	0	0
7/6, '28	0	0	2	0	0	0	2
Total	5	0	42	2	0	30	79

Percentage from top—8.87, from trunk—91.13, and from bottom—0.0

Examination of this table shows that out of a total of 79 moths from both trees 7 emerged from the top, 72 from the trunk, and none from

the ground. Obviously the trunk is the source in orchards of this kind of a bit over 91% of the overwintering generation of moths.

At the same time and because the results, which were obtained, were suspected as likely to obtain, treatments were made of the rough bark region of the trunks and the larger branches of a number of trees for the purpose of seeing whether the overwintering larvae would be de-

TABLE 4. STUDY OF A MISCIBLE TAR OIL AGAINST THE OVERWINTER-LARVAE OF THE CODLING MOTH

Date of Treatment	Tree No.	Material Applied	Date of Examination	No. of Larvae Total	Dead	% Dead
3/23, '28	I	Pineol sol.+Paranitrochlorobenzene (0.5 lb. to 1 qt.); applied as a coating with a paint brush	4/3, '28	9	9	100
"	II	Same as above	"	8	8	100
"	III	Same as above but diluted with water 1 to 2 and applied as coating with a sprayer	"	12	3	25
"	IV	Pineol sol.+Paradichlorobenzene (1.0 lb. to 1 qt.); diluted with water (1 to 1) and applied as coating with a sprayer	"	8	0	00
"	V	Same as above	"	7	1	14.2
"	VI	Same as above but diluted with water (1 to 1) and painted on with a brush	"	5	5	100
"	VII	Same as above	"	16	2	12.5
"	VIII	Untreated	"	12	0	00
"	IX	"	"	5	0	00
4/6, '28	X	Pineol sol. diluted with water (1 to 1); applied 0.5 gallon with a sprayer	4/18, '28	10	10	100
"	XI	Same as above	"	13	13	100
"	XII	Pineol sol.+Orthonitrochlorobenzene (1.5 gals. to 0.5 gal.); diluted with water (1 to 2); applied 1.5 qts. with a sprayer	"	17	14	82.3
"	XIII	Pineol sol.+Paradichlorobenzene (1.0 lb. to 0.5 gal.) diluted with water (1 to 1); applied 1.5 qts. with a sprayer	"	12	11	91.6

Note:—Trees, I, III, IV, VII, VIII, X, XI, XII, and XIII were Rome Beauty and trees II, V, VI, and IX were Winesap. Examinations made throughout the summer of 1928 by experienced growers, extension specialist in fruit growing, County agent and the Entomologist revealed no injury to the trees treated.

stroyed. "Pineol Soluble" was used as the carrying agent and finally as the insecticidal principal. "Pineol Soluble" is the third cut of pine oil which is produced by heating and distillation of pine stumps, roots and debris. This third cut is treated with a certain amount of caustic soda and certain fatty acids therein saponified making the material perfectly miscible with water. The results of these treatments are set forth in Table 4.

Examination of this table shows that that form of pine oil known as "Pineol Soluble" either alone or with additional chemicals applied in sufficient amounts will kill approximately 100% of the overwintering larvae in the rough bark portions of the trunk and branches without apparent damage to the trees which have been treated. It should be said that in making these applications the material was run well up the smooth bark of the branches for the purpose of seeing whether the tree would be injured.

In the results of this work there appears to be a clue to the possible destruction of a bit over 90% of the overwintering larvae from which the overwintering generation of moths comes without damage to the trees from the treatment and consequently the possibility of so reducing the moth population of an apple orchard that the results obtained in the three year test above set forth might be secured in the course of a single season's work. Of course, the efficiency of these trunk treatments and freedom from injury obtained during 1928 will have to be demonstrated on an orchard basis before one is justified in drawing conclusions but, to say the least, the outlook for something of this sort is promising.

MR. H. L. DOZIER: I would like to ask Dr. Headlee if he has figured out the approximate cost per tree of treatment with pine oil.

MR. T. J. HEADLEE: The particular pine oil used sells in barrel lots at forty cents a gallon. The amount necessary for the size of tree which we used, which was approximately 25 feet high, was one quart of pine oil mixed and applied with the sprayer.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by O. I. Snapp and H. S. Swingle.

PRELIMINARY REPORT ON ATTRAHENTS FOR PEACH INSECTS

By OLIVER I. SNAPP and H. S. SWINGLE, *U. S. Peach Insect Laboratory, Fort Valley, Georgia*

ABSTRACT

A number of chemicals are reported which were slightly attractive to various peach insects under orchard conditions. No attrahents were found for injurious peach insects which showed much promise of being of value from the standpoint of control.

Insect chemotropism has received considerable attention during recent years. Investigations at the Japanese Beetle Laboratory on attrahents for the Japanese beetle, and work by Peterson and Frost on attrahents for the Oriental peach moth, by Folsom and others on chemotropic responses of the cotton boll weevil, and by P. Garman on chemotropic responses of the plum curculio, stimulated our interest in the subject to the extent that a project was started at our laboratory last spring on attrahents for peach insects. While the results from the first season's work were mostly negative, it was deemed advisable to give a brief preliminary report on the project, especially for the benefit of those who are pursuing work along similar lines.

MATERIALS USED

Of the odorous chemicals reported as present in peaches by Power & Chesnut (*Jour. Amer. Chem. Soc.* 43: 1725–1739) the following were used: Linalool, Linalyl acetate, Methyl alcohol and Acetaldehyde.

In addition, the odorous constituents were extracted from various portions of the food plants of the plum curculio. The different portions of the plant were subjected to steam distillation, and the distillate again fractioned, using a Hempel still-head. In this manner the volatile constituents of a large quantity of material were concentrated into a very small volume. The following materials were subjected to distillation: Wild plum blossoms; wild cherry blossoms; wild crabapple blossoms; peach fruit, green (Elberta); peach fruit, ripe (White Hiley); peach fruit, ripe (Yellow Hiley); peach bark (Elberta). In the case of the wild plum blossoms, a sufficient quantity of the essential oil was present to enable it to be separated. This was done by shaking the distillate with petroleum ether, separating, and then evaporating away the ether, leaving the essential oil. The essential oil was then diluted with ethyl alcohol before testing in the field. In the other cases, an insufficient quantity of the essential oils was present for separation and the materials were tested in the form of a concentrated distillate.

During the course of the season's work 122 materials were tested in peach orchards as attrahents for peach insects.

Methods Employed

Laboratory tests: Several materials were tested for attractiveness to the plum curculio in the laboratory, McIndoo's olfactometer (Jour. Econ. Ent. 19: 545–571) being used. It was planned to determine with the olfactomer the portion of the peach plant most attractive to the curculio and then to attempt to isolate the attractive principle. Tests with the olfactometer of the bark, leaves, fruit, and blossoms indicated that all were slightly repellent, although the insect feeds freely upon leaves, blossoms, and fruit in the field. Tests were also run upon a series of chemicals. Of those tried, butyl acetate was the only one to which the curculio was attracted. This was then tried in the field for a total period of 42 days without attracting a single curculio. As the results of tests with the olfactometer did not seem to give any indication of the results to be expected in the field, its use was discontinued.

Field tests: Chemicals tested in the field were used in evaporation cups as described by Peterson (Jour. Econ. Ent., 19: 863–866). The cups containing the chemicals were floated on water in one-half gallon tin buckets suspended from the branches of peach trees. A film of an odorless medicinal mineral oil was placed over the water to hold the insects attracted to the bait, as many apparently escaped when only water was used. This also served to prevent evaporation of water from the pails and made the identification of specimens easier as all were retained in the upper layer of oil. The insects captured were strained from the buckets several times weekly. Each chemical was tested for approximately six weeks, being used both early in the summer and again late in the summer when possible.

Results of Field Tests

The plum curculio, *Conotrachelus nenuphar* Hbst. was slightly attracted by the following: Gallic acid, methyl formate, benzaldehyde phenylhydrazone, green peach distillate (Elberta), phenylglycine, and salicylaldehyde. Of the materials attracting the plum curculio salicylaldehyde was best in the early part of the season, while gallic acid was much the best late in the summer. Methyl formate was so volatile that it could not be kept in the cups for any length of time or it probably would have attracted more individuals than gallic acid.

The peach borer, *Aegeria exitiosa* Say, was slightly attracted by benzyl butyrate.

The lesser peach borer, *Aegeria pictipes* G & R., was slightly attracted by ethyl benzoate, calcium malate+acetaldehyde sodium bisulfite, carbolic acid (C. P. crystals), salicylaldehyde, green peach distillate (Elberta), and peach bark distillate.

The shot-hole borer, *Scolytus rugulosus* Ratz., was attracted by peach bark distillate and fermented water extract of peach bark.

The spotted cucumber beetle, *Diabrotica duodecimpunctata* Fab., was attracted by oil of thyme (white) and benzyl alcohol.

The soldier beetle, *Chauliognathus marginatus* Fab., was attracted by phellandrene, anethole, benzyl alcohol, and oil of thyme (white).

Gnats of the family *Chloropidae* (identified by C. F. Adams of the Indiana State Board of Health as belonging to the genus *Siphonella*, the species probably being *cinerea* Lw.) were strongly attracted by iso-amyl valerate. Other materials that attracted gnats of the same family were thymol, carvacrol, and methyl heptenone.

Field ants were attracted by phenylacetaldehyde and guaiacol.

The wasp, *Vespula carolina* Drury, was attracted by ethyl malonate.

Discussion of Results

No attrahents were found for injurious peach insects which showed much promise of being of value from the standpoint of control. Some of the materials here reported as attractive may upon further testing prove to be without attraction. Unless large numbers of individuals are caught, it is somewhat doubtful whether a material is attractive or merely non-repellent and the insects accidentally fell in.

Some of the materials tested may prove much more attractive when tested in a different manner. The evaporation cups used offer such a small surface for the evaporation of the chemicals that the less volatile materials seem odorless or nearly so.

The distillates from green peaches and from peach bark were slightly attractive to several insects. It is hardly to be expected that they would attract a large number of insects when used in a peach orchard where the same odor is being given off by several hundreds or thousands of trees. The same may be said of the use of chemicals present in the odorous constituents of various portions of peach trees. The only way in which the insects may then be drawn to the bait is by using higher concentrations than are already present in the orchard. This probably would not be very effective, as it is common knowledge that many chemicals, which

are attractive at low concentrations act as repellents when used in a more concentrated form.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by S. W. Frost.

FOURTH CONTRIBUTION TO A STUDY OF BAITS, WITH SPECIAL REFERENCE TO THE ORIENTAL FRUIT MOTH

By S. W. FROST, *The Pennsylvania State College**

ABSTRACT

The work with *Laspeyresia molesta* was conducted as in preceding years, placing emphasis on the attractiveness of solutions of syrups of different brands and sugar content, also continuing studies of molasses-sodium arsenite baits. Weekly collections of oriental fruit moth from thirty different baits are summarized. A number of other economic insects were attracted to baits but none, except possibly fruit flies and Noctuidae, in numbers sufficient to reduce the population. Baited blocks did not show reduction of oriental fruit moth injury.

SEASONAL CONDITIONS. June and July were abnormally cool and rainy and the catches of moths during these months were correspondingly low. The entire orchard was well set with fruit especially the Elberta and Krummel while the proceeding year there was a short crop in the Krummel block.

The percentage of oriental fruit mo h was exceptionally low and much lighter than in 1926 or 1927. Terminal injury was not conspicuous except on dehorned Elberta trees. The percentage of infested Krummel on Oct. 4 ran from 13 to 15 per cent while the same variety in 1926 showed 18 to 50 per cent and in 1927, 66 to 83 per cent wormy fruit. The percentage of parasitism was likewise low. From June 6 to August 28, over 3,000 infested twigs were brought in from the orchard in which the work was done, and only nine parasites issued from this material.

FERMENTING SUGAR BAITS. A number of different syrups were tried as attractants during the season compared chiefly upon the basis of sugar content.

ANALYSIS OF SYRUPS USED DURING 1928[1]

Brand	Manufacturer	% Sucrose	% Dextrose
Refodewah		39.8	18.5
Choice Centrifugal 29x	J. Stromeyer	37.9	19.4
Centrifugal 77x	J. Stromeyer	28.7	16.3
Refiners cheap brand	Mangels Herold	32.0	24.5
Refiners Diamond Drips Compound	Mangels Herold	35.2	19.8
Residue	Mifflin Chem. Corporation	less than 1	S. trace

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[1]Analysis made through courtesy of Dr. J. W. Kellogg, Bureau Chemistry, Harrisburg, Pa.

Weekly Collections of Oriental Fruit Moths by various Baits 1928

May				June			July					August				September				October				Var.[1]	Material[2]	Prop.[3]	Add.[4]	Dur.[5]	Total Moths[6]
7	14	21	28	6	12	26	3	10	17	24	31	7	14	21	28	4	11	18	25	1	8	15	22						
12	19	3	1	1	0	1	5	4																K	Refodewat.	1-10	5gr.S.A.	28 hrs.	46[6]
5	8	8	3	8	1	1	15	26	14	9	0	19	29	10	0	2	4	40	39	2	102	49	13	K	Centrifugal[19]	1-10	5gr.S.A.	24 hrs.	401
19	17	21	5	10	12	1	13	9	7	2	0	18	21	10	0	2	0	30	18	19	158	141	48	K	Centrifugal[19]	1-10	1gr.S.A.	24 "	581
5	4	10	3	6	5	21	154	23	8	1	2	7	12	3	0	2	0	7	5	2	11	7	1	K	Centrifugal[19]	1-10	½gr.S.A.	24 "	299
5	52	84	3	5	3	0	11	6	3	0	0	0	0	0										K	Centrifugal[18]	1-10		15 "	172
1	15	41	3	7	10	5	19	11	13	3	7	11	10	6	2	2	0	4	5	1	16	5	0	K	Refodewat.	1-10	1gr.S.A.	24 "	197
2	74	51	1	1	0	4	32	8	7	8	4	42	55	12	8	2	1	12	17	11	66	59	43	K	Refodewat.	1-10	½gr.S.A.	24 "	320
8	30	25	2	1	0	0	2	1	1	0	0	0	1	0										K	Refodewat.	1-10	5gr.T.A.	15 "	71
16	53	54	3	1	2	8	22	8	9	1	2	9	8	1										K	Refodewat.	1-10	1gr.T.A.	15 "	197
9	41	72	1	1	2	1	24	14	11	1	0	3	2	0										K	Refodewat.	1-10	½gr.T.A.	15 "	182
3	97	49	6	2	5	0	23	15	16	2	7	19	22	2	1	1	0	0	2					K	Refodewat.	1-10		20 "	272
			0	0	0	1	3	6	3	0	1													E	Sucrose	22½gr.		9 "	14
			0	0	0	1	2	0	0	1	0													E	Dextrose	22½gr.		9 "	4
			0	0	0	0	0	0	0	0	0													E	Lactose	22½gr.		9 "	0
			0	0	0	3	1	2	1	0	0													E	Levulose	22½gr.		9 "	7
			0	0	0	0	2	2	0	0	0													E	Invert S.	22½gr.		9 "	4
			0	0	0	2	7	1	0	0	0													E	Glucose	22½gr.		9 "	10
					0	2	3	6	4	2	0	3	7	0	1	0	0	1	11					E	Refiner's S.[12]	1-20		15 "	40
						33	26	6	2	0	2	18	22	10	2	1	1	0	2					E	Refiner's S.[12]	1-20		14 "	125[11]
						3	27	5	7	3	3	34	65	20	14	0	0	8	1					E	Refiner's S.[12]	1-20		14 "	190[11]
							19	143	156	60	63	317	311	180	34	10	10	49	44					E	Refiner's S.[12]	1-20		13 "	1426
								39	135	41	91	318	329	159	48	9	3	44	39					K	Centrifugal[19]	1-20		12 "	1255
									5	32	45	258	347	69	10	8	3	9	8					K	Centrifugal[18]	1-20		11 "	794
										1	4	130	139	48	27	11	2	89	17	4	148	93	19	K	Refodewat.	1-20	5gr.S.A.	14 "	792
							18	38	29	10	7	113	177	51	13	21	0	128	53	14	228	202	49	K	Refodewat.	1-20	5gr.S.A.	17 "	1152
							45	8	10	2	5	121	123	27	5	12	3	52	27	7	93	125	26	K	Refodewat.	1-20	2½gr.S.A.	17 "	691
							47	22	72	29	8	119	189	31	9	9	1	34	13	16	44	50	8	K	Refodewat.	1-10	5gr.S.A.	17 "	701
							92	52	78	34	13	59	29	9	2	1	1	14	4	0	51	40	13	K	Refodewat.	1-20	2½gr.S.A.	17 "	492
							2	2	11	0	0	5	3	0										K	Sucrose	45½gr.		8 "	23
							0	1	11	3	5	1	6	17										K	Dextrose	45½gr.		8 "	44

											27	23	117	176	25	13	5	0	28	78	12	241	154	31	K	Refodewah	1-10	2½SA	14 "	932
											24	12	140	92	37	8	5	5	82	28	6	180	182	30	K	Refodewah	1-20	2½SA	14 "	831
											0	0	45	88	33	12	9	9	68	27	10	176	139	36	K	Refiners S.13	1-10	5#SA	14 "	652
											2	0	80	202	64	44	7	2	76	16	4	141	173	33	K	Refiner's S.13	1-10	2½SA	11 "	844
											0	1	29	27	9	0	1	0	23	5	16	126	179	57	K	Refiners S.13	1-20	2½SA	14 "	479
											2	1	2	10	7	4	3	1	66	40	11	254	201	28	K	Centrifugal 14	1-10	5#SA	14 "	630
											1	2	129	197	65	24	30	17	235	41	48	386	262	49	K	Centrifugal 14	1-10	2½SA	14 "	1426
													42	181	33	6	6	3	29	8	7	35	4		K	Refodewah	1-20		11 "	354
													41	121	6	5	1	3	24	6	2	31	12		K	Refodewah	1-10		11 "	252
													115	391	99	37	2	3	17	8	2	21	8		K	Refiners S.12	1-20		11 "	703
													76	343	22	14	9	0	26	12	4	50	44		K	Refiners S.12	1-10		11 "	600
													66	203	43	4	5	3	35	11	1	34	36		K	Refiners S.13	1-20		11 "	441
													199	337	70	13	6	0	12	4	0	16	29		K	Refiners S.13	1-10		11 "	686
													17	53	116	58	19	6	25	11	0	12	26		K	Centrifugal 15	1-10		11 "	343
													136	266	60	12	2	0	8	6	3	13	10		K	Centrifugal 15	1-10		11 "	516
														51	84	11	7	4	14	11	2	22	11		K	Centrifugal 15	1-20		10 "	217 [16]
														169	151	80	12	7	32	40	9	151	51		K	Centrifugal 15	1-20		10 "	702 [17]
																2	0	0	5	4	1	9	10	5	K	Sod Arsenite	2½gr.		9 "	36
																1	1	2	5	18	3	75	61	36	K	Sucrose	90½gr.		9 "	202
																0	2	0	0	6	7	23	40	20	K	Sucrose	90½gr.	2½SA	9 "	98
																5	0	0	3	6	3	3	9	2	K	Residue	1-10	2½SA	9 "	31
14	43	29	2	6	7	2	152	193	221	51	16	379	388	59	55	1	2	6	10						E [7]	Refiners S.12	1-20		20 "	1636
23	48	30	2	1	2	5	90	185	103	15	73	148	193	32	17	6	2	0	0						I [7]	Refiners S.12	1-20		20 "	975
6	9	7	2	1	1	0	25	97	20	11	2	10	66	15	2	2	0	1	4						K [7]	Refiners S.12	1-20		20 "	281
16	10	8	0	0	1	0	48	81	20	16	10	75	64	23	3	6	1	1	0						C [7]	Refiners S.12	1-20		20 "	373
38	72	58	29	6	4	4	150	234	180	19	25	56	102	121	17	2	1	5	6						H [7]	Refiners S.12	1-20		20 "	1126
14	171	90	2	8	10	7	133	189	129	18	5	34	133	147	14	3	1	2	8						E [7]	Refiners S.12	1-20		20 "	1148
8	33	19	2	2	0	0	56	33	56	7	2	37	30	5	3	5	0	4	4	2	17				K [8]	Refiners S.12	1-20		22 "	525
2	43	16	0	0	0	3	46	36	22	6	2	10	3	2	2	1	0	2	19	4	145	69	9	K [9]	Refiners S.12	1-20		24 "	412

1. Varieties in which baits were hung: K = Krummel, E = Elberta, C = Carman, H = Hale, and I = Hiley. 2. Grade of syrup used in baits, numbers indicate the brand. 3. 1 part of syrup to designated parts of water, or number of grams per pail. 4. No. of grams added per pail, S. A. = Sodium arsenite, T. A. = Tartaric acid. 5. Dur. = duration of baits in orchard. 6. This bait was run for 19 weeks in 1927, kept over winter at the laboratory, and set out again on May 1. 7. Baits marked thus were replenished on July 26 and Aug. 7. 8. Catches from 10 pails in blocks of 200 trees with a pail on every other tree. 9. Catches from 10 pails in block of 200 trees with a pail on every tree. 10. Placed June 12, compare with 11. 11. Placed June 24, compare with 10. 12. Cheap brand refiners syrup, Mangels-Herold. 13. High grade table syrup, Diamond brand syrips compound. 14. Choice centrifugal, 29x, J. Stromeyer. 15. Centrifugal No. 77x, J. Stromeyer. 16. Bait added each week. 17. Water added each week.

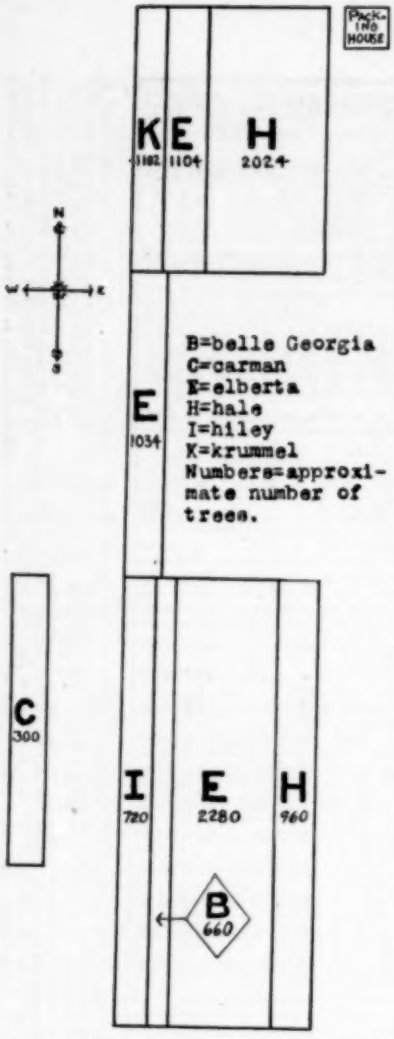


Fig. 2—Plan of experimental orchard

The results of tests with these sugars are summarized in the accompanying chart of weekly collections of oriental fruit moths. The higher grades as, Refodewah were superior to centrifugal syrups, and the higher grades of refiners syrups superior to the cheaper brands. Sucrose, dextrose and levulose, at the rate of 1 or 2 pounds per pail, did not give large catches but mixtures of these sugars together with certain inorganic compounds in the molasses were very attractive. Residue, a highly odoriferous, thick liquid but very low in sugar content, again proved useless.

In nterpreting the results, a few things should be borne in mind. All tests were conducted in blocks of Krummel (K-1102) or Elberta (E-1104) see Figure 2. Number ten, painted, tin pails were used in all cases and they were examined once a week, the insects strained from them, and counts made of the number of oriental fruit moths. Nothing was added during the operation of these baits (with one exception) but water was added at irregular intervals to compensate for evaporation or more especially the loss of liquid in making weekly collections. The pails were hung on every tree so that the different series of tests formed a solid block of pailed trees. There were fewer pails in the Elberta thus favoring the catches there.

The population of oriental fruit moth was decidedly uneven throughout the orchard especially in blocks of different varieties. This was determined in three ways. (1) Series of ten pails were placed in blocks

K-1102, H-2024, E-1034, I-720 and C-300. These were set May 1 and were operated until September 25, using the same brand of syrup and dilution and replenishing all at the same time. The catches were largest in the Hale, Elberta, and Hiley and smallest in the Carman and Krummel. The ctaches from the first three varieties ranged from 975 to 1,636 moths for the ten pails, in the latter varieties, from 281 to 370 moths. (2) Population was also determined by dusting individual trees with a four per cent free nicotine dust, placing a large white sheet beneath the trees to catch the moths. On July 23, the population in the dehorned Elberta (E-1104), where all other evidence pointed to the highest infestation at this time, averaged one moth per tree. On August 8 it averaged 10 moths per tree in the same block of Elberta. (3) Twig infestation gave a further clue to the population but was too prominently affected by twig growth. The first twig injury was noticed in block E-1104 on May 23. On May 29 twig injury averaged three to four per tree in the same block, while none was evident in the adjacent Hale or Krummel. From June 6 to August 28, 3,651 injured terminals were clipped at weekly intervals from 23 trees in block E-1104. Twig injury was scarce in H and K, the latter having stunted growth. A few of the factors affecting population and catches are noted.[2] (1) Succulent and abundant twig growth in the dehorned blocks E, also H and I, stunted growth in K. (2) a very short crop in K in 1927, an extra heavy crop in 1928, an abundant crop in E and H during both 1927 and 1928; (3) every other tree in E dehorned while none dehorned in H or K; (4) packing house adjacent to H-2024; (5) difference in time of ripening of the varieties.

Molasses Sodium Arsenite Baits. Sodium arsenite and water at the rate of 2.5 grams per pail, sodium arsenite with sucrose or with residue were not attractive to the oriental fruit moth. Sodium arsenite in solution with high grade syrups as refodewah of centrifugal molasses gave high catches. One to 2½ grams of S. arsenite per pail was found, more satisfactory than 5 grams. After summarizing the work of 1926, 1927 and 1928, the total collections from the S. arsenite-molasses baits approximate those from fermenting molasses baits. The superiority of the former rests on the fact that they attract over a much longer period and are more suited to the long hot periods of the summer months. During warm weather, fermenting molasses baits ferment

[2]Catches during 1928 were far below those of 1926 and 1927. The population was correspondingly low, Krummels at picking time showed from 7 to 68% less fruit injury than in the previous two years.

very rapidly and their duration is shortened, while the molasses S. arsenite baits can be operated to advantage. A solution of 10 grams of molasses, 100 c.c. of water, and .25 grams or .10 grams of S. arsenite (this is a 1 to 10 mixture with 5 or 2 grams of S. arsenite per pail) showed no fermentation for a period of 70 days at a constant temperature of 27° C in an incubator. On the other hand the same mixture with equal amounts of S. arsenate instead of S. arsenite started fermenting vigorously one or two days after being mixed. Molasses and water started fermenting almost immediately.

Number of Pails per Tree. In 1927 it was pointed out that the same number of moths per pail was taken whether 2, 4, 6, or 8 pails were hung on widely separated trees with no other pails in the vicinity. The same results were obtained in 1928 but on a much larger scale, when 200 pails were hung on 200 trees in one block, and 100 pails on 200 trees in a second block. In the first case, 32.5 moths per pail were taken and in the second, 44.2 moths per pail. The reverse condition, however, was attained when 1, 2, 4, and 6 pails respectively were hung on different widely separated trees in a block of 200 trees previously hung with a pail on every tree. The catches were in order; 92, 25.5, 13, and 7.5 moths per pail, showing a decrease in the catch where the number of pails was increased. The results of these different tests indicate that when the population of moths is large, the catch per pail is approximately the same whether 2, 4, 6, or 8 pails are hung on the same tree, but when the population is small (i.e. naturally or by the use of a large number of pails) the catch per pail is reduced as the number of pails is increased. On the whole, one pail to every other tree or approximately 50 pails per acre gives the maximum catch.

Dilution. Heretofore all dilution tests have been made by increasing the amount of water and thus reducing the sugar content per pail. There are two factors to consider in respect to dilution; (1) the consistency of the solution, contributing to the physical properties of the bait as foaming, surface tension, etc., (2) the sugar content of the solution, contributing to the chemical or attractive properties of the bait. During 1928 two tests were conducted, of ten pails each, with different dilutions but the same sugar content in the two series of pails. In test (1) a dilution of 1–40 was used in full size pails, in test (2) a dilution of 1–20 was used in half size pails. All the pails were kept filled within one inch of the tops during the seven weeks of their operation. In test (1), 48 moths per pail were taken and in test (2), 31.5 moths per pail. Further tests along this line are necessary but it looks as though the dilution, within

reasonable limits is not as important as the proportion of sugar in the solution. The percentage of the sugar in the solution can, for example, be increased by using higher grades of syrups without changing the dilution.

OTHER INJURIOUS INSECTS TRAPPED IN LIQUID BAITS. The peach borer (*Sanninoidea exitiosa* Say) was captured from July 3 to September 18, the males in much larger numbers than the females, indicating that baits are of little value for these insects. During this period 1,147 males and 78 females were taken.

The cherry fruit fly (*Rhagoletis cingulata* Loew) was taken in great numbers during, June especially in the vicinity of a large cherry tree. Fifty to 100 flies were often taken in a single pail.

The plum curculio (*Conotrachelus nenuphar* Herbst) was captured from June 6 to September 4 but in moderate numbers. Only 66 specimens were taken and most of these were found after storms and probably tumbled in by accident.

Of all the miscellaneous economic insects captured, the Noctuidae were most abundant. During 1927, 23,574 specimens were taken from 300 pails while in 1928, 24,783 specimens were taken from 600 pails. They were no doubt attracted by the fermenting baits.

Ten genera and 15 species of Elateridae were found in the baits, Melanotus being the most abundant, namely *M. communis* Gyll., *M. fissilis* Say, and *M. depressus* Melshm. Species of the genera *Aeolus*, *Athous*, *Ludius*, *Hemicrepidius*, *Hypnoidus*, *Origmus*, *Parallelostethus*, *Dolopius* and *Elater* were also taken.

Other species as; the flat headed apple tree borer (*Chrysobothris femorata* Oliv.), apple wood stainer (*Ips mali* Fitch), snowy tree cricket (*Oecanthus niveus* DeGeer.), and green June beetle (*Cotinis nitida* Linn.), were taken in comparatively small numbers and were probably accidental catches. *Scolytus rugulosus* Ratz. was taken, however, in quite large numbers. Well known species as the red banded leaf roller (*Eulia velutinana* Walk.) and the codling moth (*Carpocapsa pomonella* Linn.) were found abundant, especially when adjacent to apple orchards.

CONTROL. Three plots were arranged in the Krummel block (1), 200 trees with a pail on every tree (2), 200 trees with a pail on every other tree,[3] and (3), a check of 80 trees, located between (1) and (2). Refiner's syrup 1–20 was used as bait, being replenished three times between May 1 and September 23 with no further additions or attention. The

[3]Approximately the same number of moths were removed from plots (1) and (2) regardless of the fact that (1) had twice as many pails as (2).

total crop from five trees in plot (1) and (3) was cut and examined with the following results: 26.8 per cent wormy drop fruit in the check, 21.1 per cent wormy drop fruit in the pailed plot; 15.5 per cent wormy picked fruit in the check and 13.1 per cent wormy picked fruit in the pailed plot.

While there was no gain in favor of the pailed plot, there is evidence that the moths were attracted, thus increasing the infestation in the pailed plot and reducing the infestation in the check. It should be noted that the check was small (80 trees) with 350 pailed trees on one side and 200 pailed trees on the other side. (These pailed trees include the test block as well as the control blocks.)

SUMMARY. Bait pails thus far have not furnished a satisfactory method of reducing the oriental fruit moth population.

Sugar baits judiciously placed according to moth population in an orchard may aid in reducing the population.

Molasses sodium arsenite baits are superior during hot summer weather.

VICE-PRESIDENT G. M. BENTLEY: The next paper is by Alvah Peterson.

SOME FACTORS THAT LIMIT ARTIFICIAL CONTROL EFFORTS FOR THE ORIENTAL PEACH MOTH, *LASPEYRESIA MOLESTA* BUSCK[1]

By ALVAH PETERSON, *Ohio State University, Columbus, Ohio*

ABSTRACT

The problem of controlling *Laspeyresia molesta* Busck still challenges entomologists and fruit growers. To date no insecticidal control or orchard practise is known which is satisfactory or practical. The writer summarizes the more important factors that influence and limit the different artificial control measures. He also expresses his opinion on future possibilities of finding an insecticidal control measure based on ten years experience with the insect. Ovicides, larvacides, dormant control measures, light traps, attractants (baits) and repellents are discussed.

INTRODUCTION

The problem of controlling *Laspeyresia molesta* Busck, commonly called the oriental peach moth or oriental fruit moth, still challenges entomologists and fruit growers around the world. This insect now occurs in the eastern half of the United States and also in parts of Canada, Japan, Australia, France and Italy. To date no insecticidal

[1]This paper is a portion of the manuscript prepared for the Fourth International Congress of Entomology held at Ithaca, New York, August, 1928. The writer was unable to attend this meeting, consequently the paper will not be published in the report.

control or orchard practice is known which is practical or entirely satisfactory.

Since the writer is no longer conducting research on insecticides and may not be associated with this problem in the near future he would like to present some of his ideas on the possibilities and probabilities of controlling this insect with insecticides and orchard practices. The question is: what are the more important factors that limit control efforts with insecticides for the oriental peach moth and which investigators should have in mind.

Factors

The discussion of factors pertaining to the use of insecticides will be considered primarily from an insect (biological) standpoint rather than from the viewpoint of the type, cost or manner of application of the insecticide employed. In other words each stage in the life cycle of the insect will be considered separately and the habits and significant facts bearing on the problem of insecticidal control will be shown. It is assumed that the reader is fully acquainted with the location, structure and habits of the several stages of the insect.

The egg:—The eggs are thin-shelled disk-like structures usually deposited on the foliage of fruit trees. If they are coated with certain contact sprays the embryo within may be killed. This killing probably takes place in several ways: by actual penetration of the toxic product, by desiccation or by the formation of a coating on the egg shell which will cut off the supply of oxygen or physically prevent the larva from emerging. We know that certain sprays, such as nicotine or the white oils will kill 75 to 100 per cent of the eggs when coated with a definite strength. However, these products today are too expensive for practical use or they have other objectionable features.

Let us assume that an ovicide is developed which is inexpensive, easy to handle, safe on foliage and compatible with the common spray and dust materials used today. If we had such an insecticide we would still have to face several biological factors in the control of the pest by means of an ovicide.

Three of the most important of these are: (a) the location of the eggs, (b) their hatching period and (c) their period of presence in the orchard. The location of the eggs (a) on peach trees is close to 100 per cent on the undersurface of the foliage, for the most part terminal foliage. This makes it exceedingly difficult to coat thoroughly all the eggs with a contact insecticide. The hatching period (b) during most of the summer ranges between 3½ to 6 days or an average of 5 days. Eggs

are almost continuously present (c) in peach orchards from blossom time until all the fruit has been picked. These two factors (b and c) would necessitate a large number of applications if all the eggs throughout the season are to be coated and they justify the conclusion of some entomologists that commercial control by means of an ovicide is highly impractical if not impossible.

It is the writer's opinion that an ovicide would be useful if it could be combined with the regular spray or dust program. We could not expect complete control from such a procedure but the infestation might be materially reduced early in the season. The writer feels there is no justification for recommending an ovicide as a separate spray in view of the already costly and bothersome spray schedule in peach production in many parts of the United States.

THE LARVA:—The young larva bites its way out of the egg and immediately crawls about in search of food. If it finds a tender growing twig or a well developed fruit it proceeds to gain entrance. The destruction of the newly hatched larva must be effected as the larva hatches from the egg, as it crawls over the plant seeking food or as it bites its way into the plant tissue. A partially grown larva, which abandons a twig and seeks another twig (or fruit), must be killed as it bites its way out of the twig, as it crawls over the plant seeking more food or as it enters a new twig or fruit. There is little practical hope of destroying the larva with an insecticide after it has entered a twig or fruit.

Experiments show that some larvae will die as they are emerging from eggs which have been coated with nicotine sulfate a short time previous to hatching. This method of effecting control is subject to the same factors mentioned under ovicides.

Laboratory tests made by the writer several years ago showed that a newly hatched larva is likely to die if forced to crawl over fruit leaves recently coated with nicotine sulfate, beta napthol, lime, chalk and finely divided powders. Killing in the case of the first two products takes place by the evolution of toxic gases, or actual contact with the poison, while with lime, chalk, and other powders killing may take place by dessication or the product acts as a physical barrier, or the small particles may entangle the newly hatched larvae so they are unable to reach the twig or fruit where they enter. The development of an insecticide which will kill the larva as it crawls over the foliage or fruit or prohibit entrance to twigs and fruit has decided possibilities. One important factor, which is likely to be a difficult problem to overcome in connection with an insecticide of this type, is the problem of maintaining an

effective coating on rapidly growing plant tissue for the entire season, particularly in areas where frequent and heavy rains and high winds occur.

These possible methods for the use of an insecticide to prevent damage or destroy the larva of an oriental peach moth or similar larvae such as the codling moth are unusual. The commonly accepted method for the control of a chewing insect which eats its way into plant tissue is the use of a stomach poison. The oriental peach moth larva has chewing mouth parts yet it is very difficult to kill it with an arsenical applied as a spray or dust. This failure is due in large measure to the peculiar feeding habit of the larva.

A larva before entering any twig or fruit, sprayed or unsprayed, spins a loose silken web about its body and then proceeds to gouge out mouthfuls of plant tissue. The first mouthfuls are not consumed but are set to one side. After the larva has its head deeply buried in the gouged out cavity it starts to feed. This feeding habit usually protects the larva from consuming a toxic dose of the poison which has been applied to the outer surface of the twigs or fruit.

Let us assume that a stomach poison has been found which will kill the larva as it eats its way into the plant. Even though we had such an insecticide we still have to face at least two important factors if we wish to protect the peach tree from attack. The first is the rapid growth of peach twigs early in the season. Since most of the larvae attacking peach twigs enter the tip ends of the terminals, it would be necessary to maintain a coating at the end of each rapidly growing twig if the larvae are to be killed by a stomach poison. This would be practically impossible. The second factor relates to the entrance of larvae into peaches that are two-thirds to full grown. A large percentage of the larvae in infested fruit enter the peach through the tender tissue adjacent to the stem or they may enter by way of the stem. Many varieties of peaches have a very short stem and the fruit usually fits closely to the twig from which the stem arises. If you have ever tried to place a spray or dust coating on this portion of the peach when the fruit is nearly ripe the difficulty is recognized at once. Present day orchard spraying or dusting equipment is not adapted to do this kind of work, very thoroughly.

Space will not permit a discussion of other factors which are closely related with the development of a larvacide. The outlook for the development and use of a satisfactory larvacide along the line of a stomach poison, is not very hopeful while the development of an insecticide which will kill the larva in some manner as it crawls over the outside surface of the plant offers possibilities and should be investigated.

The cocoon (larva and pupa within). The full grown larva constructs a cocoon somewhere on the tree or on or in trash on the ground. A cocoon of a transforming larva is rather fragile and when constructed on a tree it may be placed in almost any depression on the branches or on the fruit (peaches), while the cocoon of a wintering larva is firmly constructed and may be placed on or in a protected place on the tree or on or in trash on the ground. Almost all wintering cocoons when spun on the tree are located between or under rough pieces of bark on the large branches or trunk of the tree. On peach trees many cocoons are frequently situated on the trunk near or adjacent to the ground.

One important factor in favor of the development of satisfactory dormant control measures is the fact that the insect has a fixed location and is in one stage of development. Such is not the case at any period during the growing season. In other words the control of this insect in the winter time resolves itself into the destruction of wintering larvae in cocoons wherever they may be located.

We know that 90 per cent or more of the larvae which winter in cocoons on the ground under trees can be destroyed by early and thorough spring plowing or deep cultivation. It is also possible to kill the larvae that are located on the tree near the ground or on the ground adjacent to the tree with paradichlorobenzene applied in the same manner as for the peach borer. These two treatments if properly conducted will kill many wintering larvae in a peach orchard; however, as a rule it will not prevent or greatly reduce the infestation for the coming season because enough larvae winter on the tree above the ground to start a moderate to heavy infestation. The writer is of the opinion that a satisfactory dormant spray would kill many of the individuals wintering on the tree, consequently insecticide investigations along this line are very desirable.

If we assume that a toxic winter spray has been found which will kill larvae in cocoons when they can be reached by a dormant spray, it is probable that difficulties still exist which will make it almost impossible for an individual grower to obtain control by dormant measures.

The following statements on dormant control express the writer's present opinion. It will be necessary to plow or cultivate thoroughly all the soil in the orchards and probably the land immediately adjoining the orchards in the spring (or possibly the fall) of the year before any adults emerge in order to destroy wintering individuals on the ground. As a rule this stirring of the soil in the spring should not be later than 7 to 10 days before the peach trees are in blossom. Many growers object

strenuously to early cultivation for they like to keep their cover crops in the orchards until the fruit is set and partly grown. Where orchards are kept continuously in sod, particularly in hilly country, cultivation is impractical. It is also probable that it may be necessary to continue to treat peach orchards with paradichlorobenzene in order to destroy the wintering larvae located on or near the base of the tree unless the toxic dormant spray employed will kill these individuals. It will also be necessary to apply the toxic winter wash thoroughly and carefully so all larvae wintering in cocoons on the various parts of the tree will be destroyed. It is very doubtful if any liquid or dust insecticide will reach some of the cocoons which are located under pieces of bark and in the most inaccessible places on the tree. Even though an individual grower could destroy a very great number of the larvae wintering in his peach orchard it is probable that satisfactory control might not result because of reinfestation from adjacent orchards. It is known that moths will fly at least one-half mile. Probably an entire community would have to make use of the dormant control measures before success would be assurred.

THE ADULT.—The adults or moths are usually present in greater or less degree in a peach orchard from blossom time until the late varieties have been picked. In the vicinity of Philadelphia the first moths usually appear early in April and the last moths of the season may be found in the orchards as late as the middle of October. This prolonged period is probably the most important factor which must be considered in the use of any control measure that aims to destroy the moths or keep them from depositing eggs.

We have learned that adults are attracted to artificial lights, to bait traps containing attractive odors, and that they may be repelled from foliage surrounded with disagreeable odors or coated with various products.

Experiments and observations extending over two years in the laboratory and in the field have shown that the control of this pest with artificial electric lighted traps is impractical and of no value. In the laboratory the moths are attracted to the colors near the violet end of the spectrum yet these same colors placed in the orchard did not seem to increase the extremely small catch of moths obtained by artificial lights.

The chemotropic response of the adult to a number of chemicals may be positive or negative. For several years the writer spent considerable time and thought on the positive response of moths to various odors. A number of fairly satisfactory sugar possessing products were found to

be attractive, especially when fermentation took place. At the present time work of this nature is being continued by other investigators and the writer believes there is a decided possibility of finding a specific and highly attractive agent for the oriental peach moth. Investigations along this line should be encouraged, yet there are important factors which must be considered even though a highly attractive product is discovered.

There seems to be a common idea among some investigators that the problem of control for any insect is solved when a specific and highly attractive agent is discovered. This is an erroneous conclusion. A larger problem presents itself after an attractive agent is discovered; namely, the question of how to use it? We have learned that many insects will come within the vicinity of certain attractive odors but it is extremely difficult to catch a very large percentage in traps possessing the attractant. In the case of the oriental peach moth the adults will appear in the vicinity of fermenting baits yet comparatively few are caught. We have liberated many marked individuals among baited traps and the percentage recaptured has never exceeded 10 per cent. To bring about a satisfactory control by baits the writer thinks that 90 per cent or more of the gravid females present in the orchard at any one time and during the entire season should be caught.

The author might discuss many interesting problems associated with baits and traps used in his experiments but this would take us into the field of chemotaxis. There is one point, however, which may seem insignificant yet it is a human factor that offers difficulties. Many fruit growers resent the entire idea of the use of attractants for they have the opinion that an efficient attractant draws insects from their neighbors. This by its nature is quite possible for the moth does not respect property lines.

Negative chemotropism offers some promise for the control of the oriental peach moth. The entire subject of repellents for insects is a field of investigation which has been insufficiently studied; consequently it is going to take considerable time to develop a satisfactory technic for testing various products. Thus far we have learned that certain chemicals placed on foliage under laboratory conditions will prevent oviposition. These are being tested in the field.

In case a satisfactory repellent is found we still face the factor of maintaining a coating or zone of repellency about the tree for the entire season. The question also arises as to what will occur if every tree in the orchard and nearby orchards are protected by repellents. Will the repellents fail to repel under these circumstances?

This suggests the theoretical possibility of using a combined program of repellents and attractants in the same orchard as proposed by Mr. Lipp. If some of the trees possess attractants and others possess repellents, it might be possible to concentrate the infestation on a few trees which would make it easier to handle the infestation with other insecticides.

This concludes the discussion of the more important factors affecting insecticidal control; however, there is one point which should be discussed. The infestation from year to year fluctuates considerably, particularly in areas where the insect has been established for several years. This has a decided influence on the attitude the grower takes toward any insecticidal control. If an insect is serious almost every year, then a grower may be willing to perform any reasonable control program to combat the insect; but where injury fluctuates from 5 to 75% of the fruit infested with larvae of the oriental peach moth, then the grower is likely to gamble and take a chance that it will be a year of light infestation, and who will say that this is not the preferable hazard?

In 1918 the writer predicted that entomologists would be looking for a satisfactory insecticidal control for the oriental peach moth for twenty-five years or longer. Ten years have passed and we have not found for the oriental peach moth an insecticide comparable to paradichlorobenzene for the peach borer. Here is hoping the prediction does not come true.

The above picture of the possibility of finding a satisfactory control for the oriental peach moth is not extremely hopeful. If entomologists and fruit growers were forced to rely entirely upon artificial control the immediate future of peach production would be very unsatisfactory. Fortunately natural enemies, parasites and fungi, and other biological factors are playing a very important part in the solution of this problem. This is particularly true in many areas where the insect has been established for five or more years. The writer would like to discuss the more important phases of natural control but the space allotted for this paper already is exceeded.

VICE-PRESIDENT G. M. BENTLEY: The next paper will be by J. W. Lipp.

PRELIMINARY TESTS WITH POSSIBLE REPELLENTS OF THE ORIENTAL PEACH MOTH

By J. WILLIAM LIPP, *Assistant Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*[1]

ABSTRACT

The writer used several methods for testing repellency in a series of experiments at Riverton, New Jersey, in 1927. Recording the eggs deposited on sprayed twigs in cages (in the insectary), and recording the number of moths coming to bait pans, with and without evaporation cups containing chemicals (in the orchard), seemed the best methods. In the insectary tests, sprays of crude alpha naphthylamine and Dippel's oil gave the most satisfactory results. The orchard tests revealed four chemicals—furfural, Dippel's oil, ammonium sulphide and amyl acetate—which showed at least 50% repellency. An apparatus for use in field studies with repellents is described.

In a recent paper, Snapp (*6*)[2] has enumerated a number of disadvantages in the bait-pan method as a control measure for light infestations of the oriental peach moth.[3] To these disadvantages may be added the necessity of replacing the water lost by evaporation from the pans, the decomposition of the bait with resulting loss of attractiveness, and the possibility, as felt by some of the growers, that, instead of lowering the number of moths present, the pans draw into the orchard more moths than would normally be present.

In view of these objections to attractants, or, at least, to the liquid bait method, and as no work on repellents for the adult moth has been reported, the author undertook a preliminary study of repellents at Riverton, N. J., the details of which are herein recorded.

The chemicals tested as repellents will be enumerated under the various tests in which they were used. Possession of a strong odor was considered in choosing them rather than chemical composition. They were used undiluted in all tests except those in which they were sprayed on twigs. In these latter tests the chemicals were dissolved or emulsified.

When emulsification was necessary, the following formula was used:[4] 2.7 grams of the chemical; 22.7 c.c. oleic acid; 3.2 grams C. P. caustic soda (96–98 per cent NaOH); 94.6 c.c. water. In the preparation of this emulsion the material to be tested was dissolved in the oleic acid.

[1]The author desires to express his thanks to Dr. Alvah Peterson, formerly in charge of Peach Insect Investigations, Bureau of Entomology, for his assistance in the conduct of this work.

[2]The numbers in italics refer to the Literature cited at the end of the paper.

[3]*Laspeyresia molesta* Busck.

[4]This formula is equivalent to the one used by van Leeuwen (*7*), the oleo resin of pyrethrum being replaced by the chemical to be tested as a repellent.

The caustic soda, dissolved in a small quantity of water, or made up as a standard solution, was stirred into the oleic acid containing the substance to be tested. The remainder of the water was then added and the whole mass stirred until uniform. Heat facilitates the preparation of this stock material, although it can be prepared cold.[5]

Insectary Tests

(Test 1) A group of 3 unsprayed twigs was placed at each end of a screen cage 12″ x 24″ x 12″ high), in which were confined 50 male and 50 female moths. A cloth bag containing the chemical to be tested was suspended in the middle of one group of twigs from the top of the cage. The group at the other end of the cage was used as a check. The twigs were examined at the end of 24 hours, and a comparison of the number of eggs found on each group of twigs was used to determine whether or not the female moth had been deterred from laying eggs on the twigs surrounding the chemical.

This method was soon discarded on account of its impracticability. The cages used were so large that many moths flew to the top of the cage and away from the vicinity of the twigs, which resulted in a small egg deposition on the twigs. The bag admits of the use of only solid, non-deliquescent chemicals which will not injure the cloth of the bag. The use of a liquid is possible, but it must be used with an absorbent material to prevent any twig injury by the drippings.

Paradichlorobenzene and naphthalene were the only chemicals tested with the bags and in the above-mentioned type of cage. The presence of either of these materials seemed to have no effect on the egg deposition. In one test with paradichlorobenzene, for example, the check

[5]In the course of this work it was found that paradichlorobenzene is quite soluble in oleic acid, 25 grams of the solid being readily soluble in 100 c.c. of the acid, at room temperature. By gently warming the oleic acid it is possible to obtain even more concentrated solutions. If the solution of paradichlorobenzene in the acid is treated with alkali as described above in the text, a concentrated stock solution is obtained which is readily soluble in, and miscible with, water and from which the paradichlorobenzene shows very little tendency to crystallize except as the temperature is lowered. The author feels that the fortification of a soap solution by the addition of paradichlorobenzene, or other oleic acid-soluble solids, may be of assistance in combating insects which are at present controlled by soap solutions, either alone or in combination with nicotine, or other alkaloids, or pyrethrum. The paradichlorobenzene may not be so toxic per se as an alkaloid, yet, from the practical side, the difference in price of the two materials might permit the use of a quantity of paradichlorobenzene sufficient to make the two sprays comparable in toxicity. Further work on this paradichlorobenzene-soap combination is now in progress.

twigs had a total of 128 eggs, and the twigs around the chemical had but 12, while in another test the check twigs had only 43 eggs, as compared with 445 on the twigs around the chemical.

(Test 2) Two small cages 6″ x 12″ x 6″ high made with screen sides and cloth tops, each containing a sprayed and a check twig, were arranged along the west side of the insectary, each cage containing 50 moths of

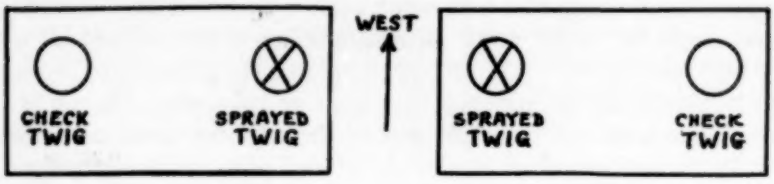


FIG. 3.—Diagram showing arrangement of twigs.

each sex. The twigs were placed as in the accompanying diagram: In this arrangement, as can be seen, there was a sprayed twig at the right hand side of one cage and at the left in the other in order to eliminate the factor of the moths' being drawn to one certain side of the cage by any outside attraction. If, after 24 hours, the sprayed twig in each cage contained but few eggs in comparison with the number on the check twig in the same cage, the eggs on the sprayed twig were crushed, the check twigs replaced by fresh twigs, the position of the twigs in each cage reversed, and the experiment repeated. (This reversal of the positions of the twigs served as a check on the location of the sprayed twig as a factor in the observed repellency.) These experiments were permitted to run until the moths ceased to produce eggs, or until they gave no further evidence of being repelled, as shown by a heavy oviposition on the sprayed twig.

This method proved to be very satisfactory since the cages could be readily handled and were small enough to prevent the moths from flying away from the vicinity of the twigs. The egg deposition was thus, to a great extent, centralized on the leaves. Some eggs were laid on the wooden framework of the cage, on the paper tags used, and on the bottles in which the twigs were placed, but this did not interfere materially with the experiment.

When this method was used the following sprays seemed to have no repellent action:

Arsenate of lead.....2 pounds to 50 gallons
Dry mix sulfur-lime (8 parts sulfur to 4 parts lime to ½ part calcium caseinate 12½ pounds to 50 gallons
Nicotine sulfate.....1 to 500
Sodium oleate.....2 pounds to 50 gallons
Paradichlorobenzene.....0.225 per cent
Pyridine.....2 per cent
Oil of Tar.....0.225 per cent
Derris compound.....1 to 500

Those showing repellent effect for one or two days were:

Nicotine sulfate 1 to 500, plus sodium oleate 2 pounds to 50 gallons
Concentrated lime-sulfur (33° Baume).....1 to 50
Dark ammonium sulfide.....2 per cent

Those showing repellent effect from 2 to 7 days were:

Crude alpha naphthylamine.....0.225 per cent
Furfural.....2 per cent
Dippel's Oil[6].....0.225 per cent and 2 per cent

Of all the materials tested, crude alpha naphthylamine and Dippel's oil seemed best. The results of the test, shown in Table 1, are typical of the results consistently obtained with 0.225 per cent solutions of these two materials.

TABLE 1. NUMBER OF EGGS LAID ON SPRAYED AND UNSPRAYED TWIGS, USING ALPHA NAPHTHYLAMINE AND DIPPEL'S OIL (BOTH AT 0.225 PER CENT CONCENTRATION) JUNE, 1927

		Day of the Month						
		1	2	3	4	5	6	7
Cage No. 1 with crude alpha naphthylamine	Sprayed twig	0	5	2	2	1	—[1]	—
	Check twig	12	40	2	11	15	—	—
Cage No. 2 with crude alpha naphthylamine	Sprayed twig	8	2	5	7	11	10	77
	Check Twig	34	168	136	110	91	28	33
Cage No. 3 with Dippel's oil	Sprayed twig	3	5	4	5	1	—[2]	—
	Check twig	33	31	38	5	2	—	—
Cage No. 4 with Dippel's oil	Sprayed twig	1	5	4	1	0	14	113
	Check twig	41	90	83	8	76	1	30

[1]Cage No. 1 discontinued June 5 because of wilting of sprayed twigs.
[2]Cage No. 3 discontinued June 5 because practically all the moths had died.

The data given in this table show that the repellent action of these chemicals, at the concentration indicated, does not last indefinitely.

[6]Dippel's oil is a distillation product of animal bones from which the fat has been removed by boiling in water. The "defatted" bones are then ground and destructively distilled. The residue is animal charcoal, or bone char, and the distillate is Dippel's oil (often called "bone oil"). An analysis of the latter is practically impossible on account of its complexity, which is evidenced by the following compounds which (with many others) have been isolated from it: nitriles, amines, hydrocarbons, pyrrol, pyridine, quinoline, phenol, and ammonia.

Furthermore, the continued lack of oviposition on the sprayed twigs was not due to their natural deterioration, for on June 6 more eggs were laid on a 5-day-old twig sprayed with Dippel's oil than on a fresh, unsprayed twig. The same was true on June 7 with 6-day-old twigs, one sprayed with alpha naphthylamine and one with Dippel's oil.

Very often in these insectary tests the sprayed twigs wilted and dried up after from 1 to 4 days. Tests with these twigs were, of course, discontinued because it is apparent that with a fresh check twig in the same cage, repellency might justly be attributed to the condition of the sprayed twig as to its odor. It can be seen readily that the duration of the repellent action of some materials could not be determined completely by the method used. However, one twig sprayed with a 0.225 per cent solution of Dippel's oil showed repellency for 7 days after being sprayed.

In a three night's test with a 2 per cent solution of Dippel's oil instead of 0.225 per cent, the results showed a total of 4 eggs for the sprayed and 201 for the check twigs. Another test for 3 nights with a 2 per cent concentration of furural resulted in a total of 17 eggs on the sprayed and 222 on the check twigs. Unfortunately the experiments with these materials (both with 2 per cent concentration) were not duplicated, because the results were not obtained until too late in the season.

Orchard Tests

For the orchard tests enameled stew pans of 2-quart capacity containing solutions known to be attractive to the oriental peach moth were placed about 5 feet above the ground in consecutive trees in alternate rows of 10 pans each. Other tests were conducted in two orchards in Riverton, N. J. In one, belonging to A. L. Richie a 10 per cent solution of brown sugar was used. In the other, belonging to H. G. Taylor, Jr., 10 per cent refiners' syrup was used (*5*). Daily examinations of the pans were made until observations indicated that a goodly number of moths were being caught. The material to be tested was then applied to the pans in one of the following two ways:

(1) The chemicals were tied into small cloth bags, as in the insectary tests, and suspended by a cord from above the pan to within about 1 or 2 inches of the surface of the solution.

(2) The chemicals were placed in evaporation cups, made with 15 x 25 mm. vials (*4*) which were floated on the surface of the attractive solution.

In both these methods the substances to be tested were applied to the five even-numbered pans, leaving the five odd-numbered pans as

checks. (Only one chemical was tested in each row.) If the pans containing the chemicals showed but few moths as compared with the check pans, the chemicals were changed to the odd-numbered pans, leaving the even-numbered as checks. In this way it was possible to see whether or not the attractive solution had been rendered unattractive by the presence of the chemical or whether the small number of moths caught was due to their not being present in the vicinity of the pans.[7]

In order to reduce all the figures obtained to a common basis, an average of moths per pan per reading was obtained for both repellents and checks from the total number of moths caught. Table 2, which gives the result of this test, shows that the average number of moths per check pan is different in the case of each chemical tried. Each average per check pan was obtained from the five check pans in each individual row, rather than making a grand average from the check pans in all the rows. In view of the variation in the distribution of the moths throughout the orchard this seemed the only fair method. When the number of moths from the repellent pans is divided by the number from the check pans, a ratio is obtained which the writer has called the "attraction ratio." If this attraction ratio is multiplied by one hundred and the result subtracted from one hundred, the remainder is called the "percentage repellency." (Table 2, last column.) For example, asafoetida had an attraction ratio of 0.789, which means that the 5 pans with the evaporation cups containing this material caught only 78.9 per cent as many moths as the 5 pans without chemicals in the same row. Multiplying by 100, and subtracting from 100, gives 21.1 per cent as the percentage repellency for asafoetida.

Paradichlorobenzene, naphthalene and alpha naphthylamine were the only chemicals tested by the former of the above described field methods, since, just as in the insectary tests, the testing of liquids by this method is practically out of the question, in view of the possibility of the material's dripping into the pan and destroying the attractive solution. With the evaporation cups, however, liquids can be safely used. Of course, there is a possibility of spoiling the attractive solution if the cups are overturned, but in these experiments there was practically no difficulty of this sort encountered. The data on all the field tests are found in Table 2.

In the column headed "Number of pan observations" each figure represents the number of chemical or check pans (5) in each observation

[7]The expression "in the vicinity of the pans" seems advisable since there is little available information as to the distance over which these solutions are attractive.

TABLE 2. DATA FROM FIELD TESTS AT RIVERTON, N. J. WITH POSSIBLE REPELLENTS[1] OF THE ORIENTAL PEACH MOTH, USING FIVE PANS FOR EACH CHEMICAL AND FIVE FOR EACH CHECK—1927

No.	Chemical	Orchard	Starting Date	Days Run	Total Moths: Chem. Pans	Total Moths: Check Pans	No. of Pan Observations: Chem.	No. of Pan Observations: Check	Average No. of Moths per Pan per Observation: Chem.	Average No. of Moths per Pan per Observation: Check	Attraction Ratio		Percentage Repellency	
1	Furfural	(T)[2]	7– 9	7	2	25	20	20	0.10	1.25	0.080		92.0	
2	Dippel's oil	(T)	6–23	23	69	582	68	68	1.01	5.82	0.174		82.6	
3	Ammonium sulfide	(T)	7– 6	10	41	108	35	35	1.17	3.09	0.379		62.1	
4	Amyl acetate	(R)	5– 2	9	28	56	20	20	1.40	2.80	0.500		50.0	
5	Pyridine	(T)	6–29	16	80	157	55	55	1.45	2.85	0.509		49.1	
6	Isopropyl alcohol	(R)	5– 2	9	47	84	20	20	2.35	4.20	0.560		44.0	
7	Anthracene	(T)	6–23	13	161	225	50	50	3.22	4.50	0.716		28.4	
8	Alpha naphthylamine	(R)	5– 2	9	72	97	20	20	3.60	4.85	0.742		25.8	
9	Calcium carbide	(T)	6–23	5	38	50	20	20	1.90	2.50	0.760		24.0	
10	Asafoetida	(R)	5– 2	9	97	123	20	20	4.85	6.15	0.789		21.1	
11	Menthol	(R)	5– 2	9	78	92	20	20	3.90	4.60	0.848		15.2	
12	Acetamide	(T)	6–23	13	173	200	50	50	3.46	4.00	0.865		13.5	
13	Concentrated lime-sulfur	(T)	7– 6	10	55	61	35	35	1.57	1.74	0.902		9.8	
14	Fish oil	(T)	7– 6	10	119	102	35	35	3.40	2.91	1.166		0. —16.6	
15	Sodium resinate	(R)	5– 2	9	92	78	20	20	4.60	3.90	1.179		0. —17.9	
16	Ortho nitro phenol	(T)	6–23	13	169	135	50	50	3.38	2.70	1.252		0. —25.2	
17	Camphorated oil	(R)	5– 2	9	54	39	20	20	2.70	1.95	1.384		0. —38.4	
18	Carbolic acid	(T)	7– 6	10	15	68	30	30	0.50	2.27	0.220	0.321[3]	78.0	67.9[3]
19	Carbolic acid	(R)	5– 2	9	43	102	20	20	2.15	5.10	0.421		57.9	
20	Oil of tar	(T)	6–23	23	90	212	85	85	1.06	2.49	0.425	0.350[3]	57.5	65.0[3]
21	Oil of tar	(R)	5–11	12	22	80	20	20	1.10	4.00	0.275		72.5	
22	Naphthalene	(T)	6–23	23	100	164	85	85	1.17	1.93	0.609	0.542[3]	39.1	45.8[3]
23	Naphthalene	(R)	5– 2	16	146	307	30	30	4.86	10.23	0.475		52.5	
24	Paradichlorobenzene	(T)	6–23	23	126	206	85	85	1.48	2.42	0.612	0.592[3]	38.8	40.8[3]
25	Paradichlorobenzene	(R)	5– 2	16	155	271	30	30	5.16	9.03	0.572		42.8	
26	Nicotine sulfate	(T)	6–23	13	87	122	50	50	1.74	2.44	0.713	0.666[3]	28.7	33.4[3]
27	Nicotine sulfate	(R)	5– 2	8	55	89	20	20	2.75	4.45	0.618		38.2	
28	Kerosene	(T)	6–23	13	107	110	50	50	2.14	2.20	0.973	0.877[3]	2.7	12.3[3]
29	Kerosene	(R)	5– 2	8	107	137	20	20	5.35	6.85	0.781		21.9	
30	Naphthalene (bags)	(R)	5–11	12	22	53	20	20	1.10	2.65	0.415		58.5	
31	Paradichlorobenzene (bags)	(R)	5–11	12	24	57	20	20	1.20	2.85	0.421		57.9	
32	Alpha Naphthylamine (bags)	(R)	5–11	12	56	54	20	20	2.80	2.70	1.037		0. — .7	

[1]It is interesting to note that furfural, carbolic acid and oil of tar have been described by other investigators (*1, 2, 3*) as showing high repellency toward other insects.

[2](R)—Richie's Peach Orchard, (T)—Taylor's Peach Orchard.

[3]These figures represent the mean of the results with the materials tested in both orchards.

multiplied by the number of observations made. (It will be noted that an equal number of chemical and check pans were used throughout.) Five chemical and five check pans were not used with Dippel's oil, however, since during the process of thinning many peaches were dropped into four of the pans in this test. Two check pans overflowed with a resulting loss of solution, and in the chemical pans, two cups with the Dippel's oil were upset. It was thus thought advisable to take the remaining results for Dippel's oil from the three check and three chemical pans out of the original 10 pans in the row.

The repellent values indicated for some of the chemicals are to some extent misleading. Concentrated lime-sulfur, for example, showed repellency in the orchard for a short time and then the surface of the liquid in the cup became covered with a heavy scum of sulfur or insoluble sulfur compounds and the repellent action ceased. The same condition was true of ammonium sulfide after about a week. Amyl acetate and isopropyl alcohol both evaporated rapidly (completely within a few days). If these chemicals had not been renewed, their repellent values would undoubtedly have been much lower than those given in the table. Pyridine also had to be renewed, but its rate of evaporation was not so great. Nicotine sulfate started well in both orchards but after about three days the pans containing the cups caught as many moths as the checks. The repellency of paradichlorobenzene seems to vary with atmospheric conditions. It is well known that the rate of evaporation of this chemical is hastened by an increase and retarded by a decrease in temperature. Furthermore, moistening with water will practically stop the evaporation of the paradichlorobenzene until the water evaporates. It may be that conditions of this sort caused the variation in the results obtained with paradichlorobenzene in evaporation cups in the orchard. In the majority of cases the repellency was marked, but in one or two observations the total number of moths caught in the repellent pans equalled or slightly exceeded the total caught in the check pans. A consideration of the atmospheric conditions of the periods during which these results were obtained seems to bear out the explanation suggested above. Detailed work with temperature and humidity of the atmosphere would be necessary before this could be proved conclusively.

It can be readily seen that the field tests revealed more compounds which offer promise as repellents than did the insectary tests. However, since the same compounds were not all used in both the field and the insectary, this comparison may not be entirely fair. It must be borne

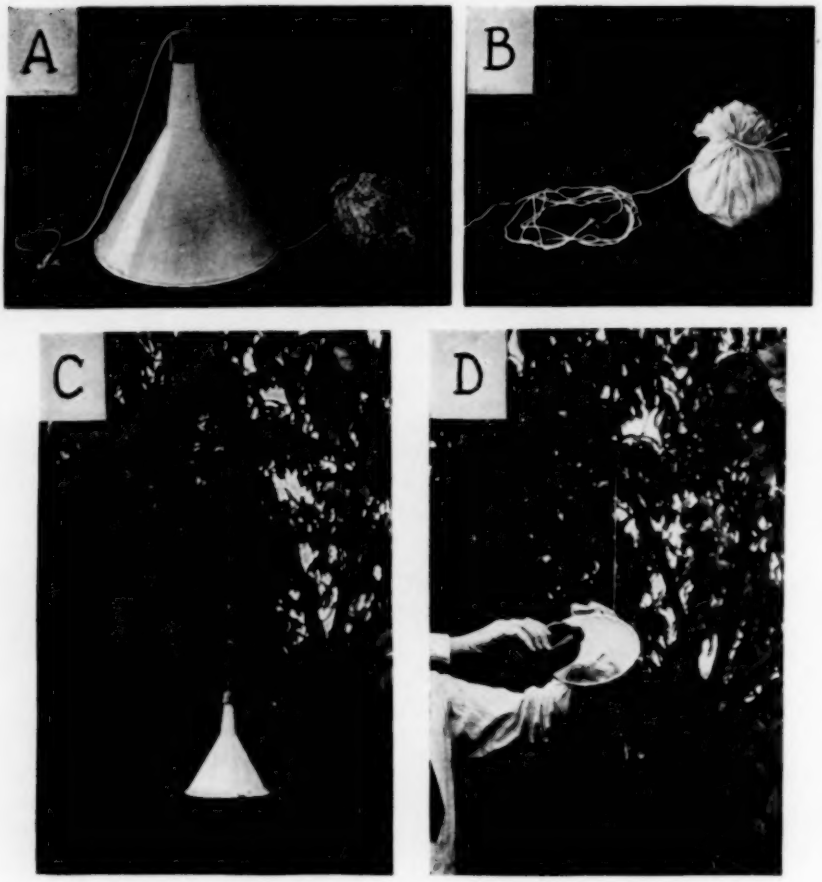
*These figures represent the mean of the results with the materials tested in both orchards.

in mind that in the tests made there are two different factors involved in the repellency. In the field tests the moths seemed to be seeking the bait pans as a source of food while in the insectary tests the twigs were sought for oviposition. For this reason, we might expect to find that a compound which is repellent in the field is not repellent in the insectary cages. In other words, an odorous material might be able to keep a moth away from a food supply but unable to overcome the desire for oviposition. Another thing to be considered is the difference in quantities of material used in the field and in the insectary. Naturally, when used in spray form, the material is much less in quantity than when used in the evaporation cups, 2 per cent lime-sulfur, for example, being used as a spray in the insectary tests while 100 per cent was used in the field tests. However, the difference in quantity used in the two tests cannot be given as the reason for the variation in the repellency. Even though 100 per cent oil of tar showed repellency in the field, while a spray of 0.225 per cent concentration showed no appreciable oviposition repellency, the conditions were entirely reversed in the case of crude alpha naphthylamine.

With the possible exception of furfural (which was tested only once in the insectary and the test of which ran for only 7 days in the field), Dippel's oil was the only material tested which was consistent in its repellency in both insectary and field tests. In view of the fact that lime-sulfur and oil of tar showed repellency in either the insectary or orchard, but not in both, the repellency of Dippel's oil in both is noteworthy.

It seems to the writer that if a practical repellent is obtained, it should be repellent from the standpoints of both food and oviposition. One of the greatest aids towards preventing oviposition, which after all is the important thing, is keeping the moths out of the trees. This assumes a greater importance when a chemical which is only an oviposition repellent has been improperly applied and some unsprayed parts offer a place for egg laying.

From June 5 to July 6, 1928, the practical application of one of the repellents which had given good preliminary results in 1927 was attempted. In view of the possibility of improper application, as mentioned in the preceding paragraph, the use of a spray seemed impractical, so the chemical was applied on wads of cotton batting which were tied, one wad per tree, in a block of 36 trees. As a result of this arrangement the odor of the chemical was very apparent at any point in the block. The chemical soon lost its effectiveness, however, as was determined



Apparatus designed for use in the 1929 tests of orchard repellents: A, apparatus partly assembled, showing make-up; B, cheesecloth bag containing solid chemical; C, assembled apparatus in position; D, funnel inverted for applying liquid to cotton batting.

by comparing the number of moths coming to bait pans in these trees with the number coming to pans in an adjacent check block. This loss was attributed largely to the action of rain, the precipitation for the period mentioned being recorded as 8.64 inches.

To overcome this difficulty the apparatus shown in Plate I, A, was devised for use during the 1929 season. It consists of a tin funnel (painted to prevent rusting), a cork, through which a hole has been bored, and a wad of cotton batting, 3 inches in diameter, tied with a piece of cord, 3 feet in length. The end of the funnel is pressed into the cork, and the cord is passed through the hole in the cork, and fastened to a limb (Plate I, C). The cork prevents the rain from reaching the chemical.

A liquid chemical may be applied by immersing the cotton batting in it before the apparatus is assembled, or by pouring it on the wad after the apparatus is in the tree (Plate I, D). The latter method may be used also in replenishing the spent chemical after the wad has been in the field for some time.

A solid chemical may be dissolved in a suitable liquid and the wad saturated with the solution. If this method does not seem feasible, a small bag, made from cheesecloth or a similar material, may be filled with the solid chemical (Plate I, B) and used to replace the wad.

The repellent value of a chemical when applied in this way will be determined by the amounts of injury to twigs and fruit in the protected trees as compared with the injury on check trees.

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MR. E. N. CORY: In connection with Dr. Peterson's paper, I think it might of be interest to call to the attention of the members that in 1918 Dr. Garman showed that the particles of self-boiled lime and sulfur were quite effective in destroying newly hatched larvae.

VICE-PRESIDENT G. M. BENTLEY: The next paper will be by F. Z. Hartzell.

RELATION OF SNOW COVER TO INFESTATION BY THE GRAPE BERRY MOTH (*POLYCHROSIS VITEANA* CLEMENS)

By F. Z. HARTZELL, *Associate in Research, N. Y. Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

In western New York, the survival of the grape berry moth during a normal winter was found to be rather closely related to the amount of snow cover present during periods when the temperature dropped to near zero Fahrenheit. Snow drifting in vineyards on level or north sloping soil furnishes the most continuous cover for the cocoons and such areas constitute foci of infestation for the pest except during abnormal winters. Practical immunity is secured either by removing obstructions that cause drifts or by avoiding the planting of vines in such places.

In the Chautauqua and Erie grape belt which extends along the south shore of Lake Erie from Buffalo, N. Y., to Erie, Pa., the distribution of grape berry moth (*Polychrosis viteana* Clem.) is sporadic except during occasional seasons when the infestation is rather general. This spotted infestation has caught the eye of practically every worker who has studied the insect in that region, and perhaps each has formed some pet hypothesis to account for the phenomenon. While the authors of most of the theories are not known, the more important seem to be as follows: (1) That wild grapes growing in waste land and woodland serve as centers of infestation. This will be designated the *wild grape hypothesis*. (2) That grape leaves containing cocoons were blown into sheltered places, especially woodland or low spots where by their mass, with the assistance of snow cover, the hibernating insects were protected. For brevity this will be known as the *dead leaf hypothesis*. (3) That the grape berry moth has a number of host plants growing in the vicinity of infested vineyards and that moths migrated from these to cultivated vines. This will be styled the *multiple host hypothesis*. (4) That the moths need the flowers of some plant or plants upon which they can feed on nectar. This will be designated the *supplementary food plant hy-*

pothesis. (5) That the moths, being crepuscular, deposit their eggs in locations shaded during the afternoon. This will be called the *crepuscular theory*. (6) That snow cover *in the vineyard*, during periods when the temperatures are 10° Fahrenheit or less, protects the insects and thus allows them to survive, while those insects in cocoons not protected by snow perish. The last is a hypothesis developed and tested by the writer during the past ten years and will be shortened to the *snow-cover* or *snow-drift hypothesis*.

Hibernating Habits and Factors Favoring Survival

The larvae of the second brood attain full growth in the ripening fruit from which they crawl, and each insect forms a cocoon by cutting out a small portion of a leaf and folding it, inside of which it spins its silken covering. The cocoon is connected at each end with the leaf by a small, un-cut portion of leaf tissue. Most of the second brood larvae do not form cocoons on leaves remaining on the vine, but lower themselves by a silken thread to the ground and make these structures on the sodden leaves. Later, if the leaf dries and is disturbed by force, as the wind, the cocoon breaks loose from the leaf and rests on the ground while the leaf may be blown away and lodged in a sheltered place.

In a climate such as is found on the southern shore of Lake Erie, where zero Fahrenheit temperatures occur, especially when these are sudden and of considerable magnitude, all observations indicate that the vast majority of pupae perish if the hibernating cocoons are exposed to the rigors of winter unless some form of cover be present. Air temperatures 10° Fahr. or lower appear to be fatal to the insect in unprotected cocoons. Whether this is due to sudden changes in temperature or to the actual temperature experienced has not been determined; but it is believed that the former is the more important factor.

Vineyards that are fall plowed for a succession of years frequently develop severe general infestations of grape berry moth, while spring plowed vineyards with the same environmental conditions do not develop "wormy" grapes except during seasons when infestation is general. The injury in fall plowed plantings is brought about because the grape grower is assisting winter survival of the insects. The land is usually plowed toward the grape rows, thus covering the leaves and cocoons under the vines with an excellent protection of earth. Then, in the spring, the ground is worked away, exposing the cocoon to sunlight and air and the moths emerge with a relatively small mortality. In such areas snow cover exerts very little influence on the rate of survival. The vast majority of vineyards in the region under discussion are not fall

plowed, and it is in relation to these that the hypotheses given above have been formulated. In such vineyards three forms of cover may be found: litter, soil, and snow. Except with dense cover crops that form mats of dead vegetation under the rows, dead leaves form the principal litter; but is seldom sufficient to offer much protection owing to the ridge usually left underneath the rows to prevent water standing about the vines. As regards soil covering, some of the cocoons may become covered with ground due to the action of fall rains. This factor may be of some importance on the heavier soils, but on gravelly and sandy soils it is of small importance. Snow cover is the most important protection of the grape berry moth. This will be further amplified later.

Distribution of the Infested Areas

In order to determine the causes of the spotted infestation of grape berry moth in Chautauqua county, New York, the writer, about ten years ago, supplemented the microscope and the insectary with the plane table and later with the transit and stadia rod. It was believed (and the belief has been justified) that ecological mapping would throw some light on the problem. Perhaps the instruments were not as important as the change in point of view, but topographical surveying methods certainly led to a new concept of the problem. Omitting years when the infestation was rather general, if an infested area was found it was mapped together with the surroundings, including adjoining or nearby vineyards having no infestation. Sometimes only notes were taken, but whether by maps or notes there were included the slope of the soil, location and height of trees, waste land, buildings, etc. Also, counts or estimates were made of the degree of infestation in various parts of the area and these were located on the map. Then isofagal lines were interpolated. Snow cover records were kept each winter.

From the data collected the following relations were apparent during a year when the infestation was spotted (which may be called an ordinry year): (1) The infested areas were practically always limited to soil that was level or had a northerly slope, but the soil type was not a factor since injury occurred on all types of soils. Frequently in the same vineyards, when other environmental factors were similar, northerly slopes were infested while southerly slopes were "clean." The northerly slopes of kames and kettle holes were injured, while southerly slopes were without "wormy" grapes. (2) Many infested areas were found in proximity to woodland. Where woodland adjoined a vineyard at a distance of less than 75 feet the infested area was to the east and north of the woodland, while vineyards west or south of the wooded area were free

from the pest. In a number of instances such opposite conditions were found in the same vineyard. (3) Hedge rows and fence rows grown up to sumac and other low trees and shrubs were frequently associated with areas of "wormy" grapes. Here again, vineyards to the east or north were injured while those to the west or south were clean. (4) Wild grapes in nearby woodland or waste land were associated with infested areas only when the woodland was distant from the vineyards a distance of less than 70 feet. (5) Vines near (that is, within 50 or 75 feet) buildings showed infestation if they were to the east or north of the buildings, but were free from the pest if situated to the west. (6) In one instance a large sign-board about 40 feet long and 18 feet high had been built within 20 feet of vines and in a few years those to the east of the structure became "wormy" where previously there had been no record of injury during ordinary years. (7) The portions of infested areas where the number of berry moth was greatest coincided with areas in which snow drifted and remained longest, such places being to the east or north of obstructions that would cause the snow to drift, and when the land was level or had a northerly slope; conditions favoring slow melting of the snow owing to the rays of the sun striking it more obliquely than on southerly slopes. Shading during the afternoon also was a factor in retaining snow cover. (8) During ordinary winters, one or more warm periods occurred which caused the ground to become bare everywhere except in such places as were favorable for the preserving of snow cover, especially where drifting had occurred. Extremely cold weather (10° Fahr. or lower) frequently followed such warm spells. (9) Seasons having general infestation of grape berry moth were found to follow only winters when there had been continuous snow cover or when the weather had been very mild thruout. The most severe general infestation observed by the writer occurred when two such favorable winters followed in succession.

Returning to a consideration of the several theories that have been postulated to account for the distribution of the grape berry moth, each will be discussed in order.

The wild grape hypothesis does not fit the facts very closely because many severe infestations were found during ordinary years where no wild grapes were found in the vicinity and wild vines were found near vineyards which were clean. Also, where woodland or waste land contained infested wild grapes, vineyards directly east or north were infested while those to the south or west were free. This condition can be explained more easily by the snow cover hypothesis discussed later.

Again, during a year of general infestation vineyards far removed from wild grapes or even woodland were attacked almost as severely as those in the proximity of the wild species. However, it cannot be denied that some infestation comes from wild vines, but the point to be emphasized is that snow cover seems to be a much more important factor.

The dead leaf hypothesis fails to account for the infestation because if it did then woodland, waste land and hedges to the east of a vineyard, which collect many times as many grape leaves as similar places to the west because of the prevailing winds and gales being westerly, should produce the greatest infestation on the east sides of the vineyards. Just the reverse is true. Slingerland[1] called attention to the fallacy of this theory when he showed that very few moths were reared from collected leaves. However, the error persists in rather recent literature as well as in the minds of growers.

The multiple host plant hypothesis was partly disproven by Slingerland when he reared several species that were similar to *Polychrosis viteana* from wild plants. There seem to be no records of the latter species feeding on plants other than those belonging to the genus *Vitis*. The studies of the writer have failed to bring to light any additional host. The idea persists, however, in the minds of grape growers.

The supplementary food plant hypothesis has never been proven nor disproven. It is difficult to observe the moths actually feeding on plants. On the other hand, no plant has been observed as occurring in common with all the infested areas and, particularly, blossoming when both the first brood and the second brood of moths are in flight. In a general infestation where the vineyards are kept clean of other vegetation the degree of injury is frequently as great in the center as it is near the edges of the vineyard. The opposite should be the case if the moths must depend upon certain plants in flower for food.

The crepuscular hypothesis does not fit the facts nearly as well as the snow-cover hypothesis, even during an ordinary year. Altho it might seem to apply to infestations where woods are associated with vineyards, it fails in the case of waste land grown up to scrub timber, in the case of many fence and hedgerows, and in the case of many man-made structures. It especially fails in the case of a general spread of the insect.

The snow-cover hypothesis seems to fit the facts rather closely. During an ordinary year places with the heaviest infestations are found only where snow drifts normally occur *in the vineyard* during the winter, and especially where the drifts are retained most tenaciously. Such

[1]Slingerland, M. V. Bulletin No. 223. Cornell Agr. Exp. Station. 1904.

places are on north sloping soil in the lee of obstructions like woods, hedges, fences, buildings, knolls and where steep slopes succeed rather level ground or occur in kettle holes. Also it affords the best explanation for the fact that a general infestation occurs only after winters of uniform snow cover or when temperatures are moderate thruout the dormant season of the insect. Perhaps the best evidence in favor of this hypothesis is afforded by the fact that when either the obstructions were removed for a distance of only 70 feet from the vines or, where a wood lot belonged to others, a strip of land from 70 to 100 feet was left for other crops by removing the grapes, grape berry moth ceased to be a problem in the same vineyard where previously the fruit had been practically worthless each year. This was especially noticeable in one vineyard adjoining a woodland having many wild grapes which were not removed. By allowing the strip of land to be without vines, the drifts that came every winter simply did not reach the vineyard and, consequently, did not cover any cocoons that might have been present under the vines. The grower's reason, however, was based on the observation that the vines near the woods were the most seriously infested. Other growers removed the sumac and other woody plants from fence rows or property lines and secured immunity because they prevented the drifting of snow. Of course the farmers removed them because of either the multiple host plant or dead leaf hypothesis.

Remedies

In the Chautauqua and Erie regions a very important aid in control can be secured by avoiding fall plowing and preventing the drifting of snow in the vineyards. The latter may be accomplished in many instances by removing obstructions which cause the snow to drift. When buildings or timber are too valuable to remove, or belong to others, then the removal of vines in the area where drifts usually occur will afford protection. If woodland can be removed, it is necessary to clear a strip only about 100 feet wide adjoining the vineyard. In glaciated soil where kames and kettle holes occur in vineyards there may be no method of overcoming the drifting of snow, and then recourse must be had to spraying if the land is continued in grapes. On hillsides it may be possible to erect snow fences, as in highway and railroad practice, and drop the snow before it reaches the vineyard. By a study of the farm in relation to snow cover it is possible to learn just what areas hold snow the longest. The owner can, then, either remove the cause if possible or avoid planting in such spots. If each grape grower in a certain region or locality were able by these simple means to rid his

vineyard of grape berry moth during ordinary years, there would be fewer insects when a mild winter or a winter when the snow cover is continuous occurs, thus preventing a general infestation except under unusual circumstances when several winters favorable for berry moth survival might appear in succession. It is obvious that the remedy would fail in localities or regions where the snow cover is continuous or the winters are mild, even with little snow cover. Also, where there are numerous centers of infestation a few growers could not escape a general infestation when winters such as just described occur. Again, growers who practise fall plowing cannot hope to gain any benefit by the application of the remedies suggested to control snow drifting.

VICE-PRESIDENT G. M. BENTLEY: The next paper will be by H. L. Dozier and H. G. Butler.

LIFE HISTORY AND CONTROL OF THE GRAPE BERRY MOTH IN DELAWARE

By H. L. DOZIER, *Entomologist*, and H. G. BUTLER, *Assistant Entomologist*,
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ABSTRACT

Polychrosis viteana is now rated as the worst enemy of grapes in Delaware. Life History studies during 1928 show that nearly a full third brood developed in the vicinity of Camden while only a partial third brood took place at Newark. In the Camden section the earliest moths started to issue on May 28th but careful field observations showed that grape berry moth eggs started general hatching in the field on June 25th. Under control, emphasis is placed on clean up of leaf accumulations in old hedge rows and grassy strips between vineyards, the use of a good sticker and spreader, and the timeliness, thoroughness, and manner of application.

While this insect is known to have been present in Delaware for at least sixteen years (fidé Dr. Manns of this Station) it was not until the summer of 1926 that it began to occasion noticeable losses. Although it is believed to be now generally distributed over the most of the State it has caused large losses only on comparatively few properties. The insect, however, appears to be spreading rapidly and is causing more concern and larger losses annually. It is now rated to be the worst enemy of the grape in this section.

Life history studies of the Berry moth were begun during the past season in order to determine the habits and number of broods in this section. Extensive parallel series were conducted at the local Newark insectary and at the newly established Camden insectary. The large scale life history series at the two stations show clearly that a partial third brood of worms occurred in Delaware under the conditions existing in 1928. Even the distance between the Camden and Newark insec-

taries (the Camden insectary is 45 miles south of Newark) showed that this insect started its work later in the spring at the latter location and that its activities were cut much shorter. While nearly a full third brood developed in the Camden vicinity only a partial one took place at Newark. It is also interesting to record these late worms working long after the commercial grape crop had been cut and marketed in the old scattered partially shattered, clusters overlooked or left on the vines.

Investigations at the Camden, Delaware Insectary

To start these investigations nine sacks of old leaves were collected in May in an old vineyard known to have been heavily infested the previous two years and placed in a large screened cage. From this material a straggling emergence took place from May 28 to July 7th. No eggs were deposited and stock was then obtained by collecting the infested berries as soon as they could be found in the vineyards. The first grape berry moth eggs under field conditions evidently started hatching on June 25, 1928 as newly entered berries were abundant on that date on the property of Geo. P. Hudson and others near Dover. Close field observations during the preceding summer of 1927 had shown the young worms to be hatching and entering the berries on June 23rd.

The first of the mature worms left the berries on July 1st and the last on July 31, 1928. A total of 987 mature larvae of this brood were obtained from infested material. The feeding period is considered to extend from the time of the hatching of the egg to the time the larva enclosed itself in the leaf-fold and the latter act usually occurred on the same day the larva left the fruit. A total of 617 pupae were carried through and the maximum length of the pupal stage was 14 days, the minimum of 9 days and the average 11.02 days. The first of these adults issued on July 12th and the last on August 12th.

Freshly issued moths readily mated in stock glass jars in the insectary and a total of 3107 eggs of this brood were obtained. From two to three days usually elapsed between emergence and the beginning of egg laying.

The duration of active laying period of the adult was not long, the maximum being 11 days. Hatching of the second brood eggs started July 21st and continued until August 22 and out of a total of 891 accurately observed hatchings the average incubation period required 3.96 days, the minimum 3 days, and the maximum 6 days. The grape berry moth practically always lays its eggs on the young berries and in only a few instances have eggs been found on the stems.

The mature second brood larvae started leaving the fruit on August 8 and on September 20, the last one of the brood was observed. The average length of the feeding stage of the second brood larvae was 20.3 days with a maximum of 38 days and a minimum of 10 days. The mature larvae of this brood were leaving the fruit for a period of 44 days, some cocooning as late as September 3rd. Mature larvae of this brood continued to leave the fruit until September 20th but none of those leaving after September 3rd transformed.

The average length of the pupal period of this brood was 12.88 days, with a maximum of 24 days and a minimum of 9 days. The first adults of this brood emerged on August 20 and the last on September 22. The length of time before oviposition now averaged 4.75 days and the number of days from emergence to last oviposition averaged only 9.5 days.

The first eggs of the third brood were deposited on August 26 and the last October 6, a period of 41 days. A total of 738 eggs were obtained and the average length of the incubation of 349 of these, successfully hatched, was 7 days with a maximum of 14 days and a minimum of three days. The first eggs of the third brood hatched on August 29. As the season advanced the number of days required for the larvae to mature increased. The average length of the feeding period of the third brood larvae was 26 days with a maximum of 45 days and a minimum of 17 days. Larvae in the insectary matured and left the fruit as late as Nov. 10.

On September 7th, eight quarts of berries were gathered in a badly infested vineyard near Dover by shaking bunches over a receptacle and collecting those that fell. From this small lot of berries a total of 837 larvae matured and left the fruit.

Investigations at the Newark, Delaware Insectary

The life history investigations at the Newark insectary had to be started with field-collected first brood larvae. In marked contrast to the heavy infestations in the Dover vicinity the infestations at Newark were never extremely heavy. Careful inspections were made throughout the season of the Experiment Station vineyard without finding this pest at work. Back yard plantings of grapes showed newly "stung" berries on July 5, 1928.

A large amount of infested grapes were collected but as the definite date of entrance into the fruit was not known, no records were kept on the length of time the larvae fed. The first larvae cocooned on July 21 and the last worms of the lot cocooned on August 5. The maximum length of time before emerging as adults after cocooning was 13 days,

the minimum 9 days, and the average 10.87 days. The earliest of these first brood moths issued on August 1st and the last on August 18th. The peak of emergence of this brood was on August 3rd.

The adults readily mated in stock jars and eggs were deposited from August 3rd to September 13th. The greatest number was deposited on August 11 when 348 eggs were laid. On September 6, 7, and 8 no eggs were found deposited and the temperature for the preceding evenings was 58°. A record was kept on the longevity of adult life under insectary conditions, sustained on honey-soaked sponges. The minimum was ten days, the maximum 33 days and the average was 19.27 days.

Eggs of the second generation began to hatch on August 5 and continued until September 5th on which date no eggs were deposited. This was clearly due to the low temperatures prevailing. The highest temperature the day before (August 4th) was 73° at 2 P. M. and on August 5 it went as low as 56° and the highest point it reached on that date was 64° at noon. On September 6, the eggs began hatching again and continued through September 9th. None hatched on September 10th and incubation records were stopped for the brood. The largest number of newly hatching worms entered the berries on August 18 and the temperature on that day was 83°. The minimum number of days for incubation was 3.55 and the maximum 8.

The mature second brood larvae started leaving the fruit on August 29 and others as late as Sept. 20th, the larger part between Sept. 5 to 15th. The maximum length of time spent in the cocooned stage to emergence of this brood was 15 days, the minimum 10 days, and the average 13.5.

All moths that emerged from the second generation series were put into a stock cage. The first moths issued on August 31st and the succeeding moths that issued were placed in the same jar. The first eggs were deposited on Sept. 13th and were starting to incubate when they dried up on September 16th. No further eggs were secured.

At Newark four species of parasites (det. by R. A. Cushman) were reared during July from the Grape Berry Moth, *Bassus annulipes* (Cress.), *Glypta mutica* Cush., *Dioctes obliteratus* (Cress.), and *Microbracon* sp. Of these *Bassus annulipes* was the most abundant.

Control Methods

In Grape Berry Moth control the first important step to take is to clean up around the fields. Burn thoroughly all leaf accumulations in old hedge rows and in the grassy strips between vineyards and along the edges. This measure will also aid materially in destroying overwintering leafhoppers. Cover crops should be plowed under in spring as early as practicable.

It is extremely important to use a good sticker and spreader in attempting Grape Berry Moth control as it is a difficult matter to get the spray to stick on the grape clusters themselves. For this we have found the pure "Choice light pressed" Menhaden fish oil to be the cheapest and most efficient, used at the rate of one quart to the 200 gallon tank. This spreader must not be used later than June 20th on grapes in this section as after that date one runs into the possibility of over spray residue.

The "trailer" method of application, using two four-foot rods with double 45° angled nozzles, has given the most satisfactory results, and this is especially true in the case of the second and third applications. Field observations for the past two years indicate the necessity of including lead arsenate in the pre-blossom spray. On June 23, 1927 newly hatched larvae were just starting to enter the very small berries in the Nat Taylor vineyard near Dover. As the pre-blossom spray had been applied ten days previously this clearly demonstrated the necessity of insuring early protection by including the poison in the pre-blossom application. The thoroughness of the second and third applications is all important and the growers should be impressed with the necessity of covering the grape clusters and not the foliage.

If for any reason the first brood has not been controlled a great deal of good can be accomplished by late spraying although one must consider carefully the danger of spray residue.

Mr. F. Z. HARTZELL: What is the usual lowest degree of temperature prevailing in Delaware?

Mr. H. L. DOZIER: The average lowest temperature runs about 4 to 5 degrees above zero and I believe the lowest temperature recorded for the State is 16 degrees below zero.

MR. F. Z. HARTZELL: I believe that the snow cover hypothesis would not hold in Delaware because of the mild climate. When mild winters occur in Western New York, even where there is little snow, the grape berry moth survives in large numbers. However, during normal winters, the hypothesis seems to explain the distribution of the infestation.

VICE-PRESIDENT G. M. BENTLEY: The next paper will be by C. R. Phipps.

SYNEDA ALLENI GRT., A CUTWORM DESTRUCTIVE TO BLUEBERRY IN MAINE

By C. R. PHIPPS, *Associate Entomologist, Me. Agr. Exp. Station*

ABSTRACT

Under Maine conditions a number of species of climbing cutworms attack the blueberry in the early spring. During seasons of unusual abundance they cause severe crop losses by destroying the swelling fruit buds.

Syneda alleni, unlike the common forms, appears in the larval stage in midsummer. While the species was described in 1877 the writer has found no economic record concerning it nor any previous account of its seasonal history or immature stages.

A very severe outbreak of looping worms occurred in certain Maine blueberry fields in 1927. The outbreak reached its height in midsummer just prior to picking time. Leaves, green and ripe berries, and even the bark were eaten.

During the following June (1928) moths of the species, *Syneda alleni*, appeared by the millions in the fields which had been infested by the loopers the previous summer. Eggs were obtained on June 28 and larvae on July 4. Because of their slender appearance, looping movement, diurnal habit, and extreme activity, the larvae resemble the geometers quite closely.

Spraying with arsenate of lead at the rate of one and one-half pounds in 50 gallons of water gave good control.

Fermenting bait composed of syrup, water, yeast and honey gave an average catch of about 200 moths per pan.

Under Maine conditions the blueberry is subject to attack by a number of cutworms. With the exception of the species under discussion, all the forms which we have thus far taken on blueberry have exhibited the same general habits as our common climbing garden cutworms. In fact such well known species as the spotted, dingy, W-marked, and black army cutworm feed on the blueberry. These worms begin to work early in the spring before garden crops are up and, during seasons of abundance, they produce heavy crop losses by destroying the swelling fruit buds. In 1925 an extremely widespread outbreak of the black army cutworm, *Agrotis fennica* Tausch., resulted in a loss to blueberry growers alone of several hundred thousand dollars. Since then night collections have revealed the surprising fact that over 15 species of cutworms, many of which have no previous economic record, feed on blueberry in Maine. It is interesting to note that destructive outbreaks are always confined to "new burn" fields which may be defined as those burned over during the spring of the preceding season. The partly grown overwintering larvae become active during the first warm nights in the early spring and remain hidden away in the daytime.

Syneda alleni was named by Grote in 1877 from material collected in Orono, Maine. Since then the moths have been taken in a number of

places in Canada but the writer has found no record of an economic nature concerning it nor any account of its seasonal history or immature stages.

Economic History in Maine

During the spring of 1926 the writer reared one moth of this species from a collection of pupae taken in a blueberry field near Sebago Lake. There was nothing to indicate whether the larva had fed on blueberry or on some other plant growing in the same field.

In 1927 a very severe outbreak of looping worms occurred in certain blueberry fields in western Maine. One grower, in particular, suffered a loss of approximately 1500 bushels of berries valued roughly at $5000. Because of his extensive holdings the owner did not discover the presence of the worms until they were practically through working. A few of the larvae were later sent to Washington for identification and they were determined as *Syneda* sp.[1] Suspecting that there might be some connection between these larvae and the *Syneda* moth reared in 1926 we were on the watch for similar moths in 1928. By the third week in June moths of the species *Syneda alleni* were present by the millions in the territory infested the previous summer.

Nature of Injury

The outbreak of 1927 occurred in midsummer and attained its height just prior to picking time. The caterpillars were present by the millions about the last of July and they ate leaves, green and ripe berries, and even the bark. Many other plants in the fields were stripped in addition to the blueberry. Defoliation occurred so late in the season that the plants had no opportunity to recover and consequently they produced no fruit buds for the following season. Thus a practically complete crop loss for two seasons resulted.

Appearance and Habits

Syneda alleni Grt., belongs to the noctuid subfamily *Erebinae* of which the destructive cotton worm is also a member. The original description is as follows:

Syneda alleni, N. S.

Male. "A beautiful species allied to *graphica*, but distinct by the orange yellow primaries and under surface. Band on hind wings narrow, twice deeply scalloped, angulated on vein 2, where it is joined to the base by black scales along the vein; thick discal lunule. Primaries like *graphica* but more brown; the median shade brown and diffuse; the t. p. line notched below the costa; the t. a. line running down to internal margin, slightly projected outwardly on submedian vein. Beneath bright

[1]Determined by Carl Heinrich, U. S. Nat. Museum, Washington, D. C.

orange yellow, with deep black bands joined and forming Y marks on both wings. Larger than *graphica*, and a more striking species. Expanse 32 mil. Orono, Maine. Mr. Anson Allen, to whom this species is respectfully dedicated."

We noted that the males possess peculiar penciled tufts on the fore legs. These light colored hairy tufts may be extended or folded in somewhat after the fashion of a fan. Dr. J. B. Smith in 1907 described similar sexual characters among the noctuidae as olfactory in nature. The moths are brightly colored and are day fliers.

The larvae differ from the common type of cutworm larvae in many ways. In the first place their bodies are slender resembling geometrids. Furthermore they possess but three pairs of functional prolegs, the other two pairs being extremely rudimentary. Due to this fact the worms move with a "looping" motion characteristic of the geometrids. They are exceedingly active often jumping from one plant to another when disturbed instead of curling up and dropping to the ground in characteristic cutworm fashion. Moreover they are day feeders and appear in midsummer instead of early spring.

The first instar larvae are light gray in color without perceptible markings. As they become more mature their color becomes much darker and takes on a brownish cast. In the full grown specimens a wide, dark-brown, dorsal band extends the length of the body. Below this on either side are narrower and lighter colored subdorsal areas which are faintly mottled with wavy reddish lines. Below these lighter bands are dark-brown spiracular stripes. The ventral area is somewhat lighter in color and is faintly mottled with reddish lines. The head capsules vary in width from about .18 mm. in the first instar to 1.4 mm. in the last instar. The full grown larva is about an inch in length.

The eggs are spherical, light gray in color, faintly reticulated, and have a diameter of about .42 mm.

The pupae are light brown, about 7 to 8 mm. long, from 2 to 2.5 mm. wide, and have cremasters with 4 spines.

Seasonal History

The moths emerge from the overwintering pupae early in June and are present in the fields for about a month. Moths taken in the field on June 21 began egg-laying in captivity on June 28. The first larvae hatching from these were observed on July 4 and by July 10 all the eggs had hatched. On July 11 many first and second instar larvae were found in the field and by that date very few of the parent moths could be found. The total period of larval development from egg-hatching until pupation was between 8 and 9 weeks.

Control Experiments

Spraying. Preliminary experiments in the use of lead arsenate applied at the rate of one and one-half pounds in 50 gallons of water gave good control in connection with the early instars.

Baiting. The abundance of the moths afforded an excellent opportunity to test various attractant baits. We employed as containers enameled quart and a half stew pans. These pans were then half filled with the attractive liquid and placed at intervals of twenty-five or thirty feet in one corner of the field.

The best results were obtained from pans containing fermenting bait composed of light Karo syrup (one part in twelve parts of water), yeast, and a small quantity of honey. At the end of one week these pans were examined and gave an average catch of 90.8 moths per pan. Another series containing the same ingredients with the exception of honey yielded 53.7 moths per pan. One series of 15 pans examined twice gave a total catch of nearly 3,000 moths. While this experiment was not extensive it was suggestive enough to encourage further trial.

Mr. W. E. Britton: I would like to ask Mr. Phipps about the species defoliated by these cutworms.

Mr. C. R. Phipps: They feed on a great many plants, including all species of blueberries and many other plants.

President W. B. Herms: The next paper is by M. McPhail and C. I. Bliss.

SEASONAL HISTORY OF THE MEXICAN FRUIT WORM (*ANASTREPHA LUDENS* L.) IN CUERNAVACA IN 1928

By M. McPhail and C. I. Bliss, *Mexico City, Mex.*

(Withdrawn for publication elsewhere)

President W. B. Herms: The next paper is by H. L. Dozier.

FURTHER RESULTS WITH FISH OIL AS AN ADHESIVE

By H. L. Dozier, *Entomologist, Delaware Agricultural Experiment Station, Newark, Delaware*

Abstract

Results are briefly given of the use of pure Menhaden fish oil as a sticker for lead arsenate with various spray combinations. Over one thousand acres of fruit in Delaware during past season were sprayed with excellent results with the fish oil used as a sticker in the early sprays. On account of its wonderful sticking qualities this material can be recommended with safety only for use in the early sprays.

The preliminary work[1] conducted last season in Delaware with pure "Choice Light Pressed" fish oil as a sticker and spreader in orchard and

[1]Dozier, H. L. "Fish Oil as an Adhesive in Control of the Grape Berry and Codling Moths." Journal of Economic Entomology, Vol. 21, No. 1, February, 1928.

vineyard having shown great possibilities, the work this season was carried out on a much larger scale. Having very limited laboratory facilities, an attempt has been made to work out its practical application and place in our orchard and vineyard spray programs in the field in cooperation with our growers.

During the past season thirty-one, widely scattered growers have cooperated in this work, representing over a thousand acres of fruit. In all, 198 acres of grapes, 791 acres of apples, and 4 acres of peaches have received at least one spray in which the fish oil was used. At the close of the season a questionnaire blank was sent to each cooperator as well as a personal visit made and the tabulated results show that practically every grower was unanimously in favor of using this sticker again for the coming season. Not only were they satisfied with the results but most of them were enthusiastic over the fine-looking clean fruit at harvest time. The fish oil was added to the spray mixture as the last ingredient, with the agitator running. It mixed readily without any gumming of pipe lines or nozzles and the few cases of complaint came from growers with barrel sprayers or traction outfits where the material was simply dumped in indiscriminately.

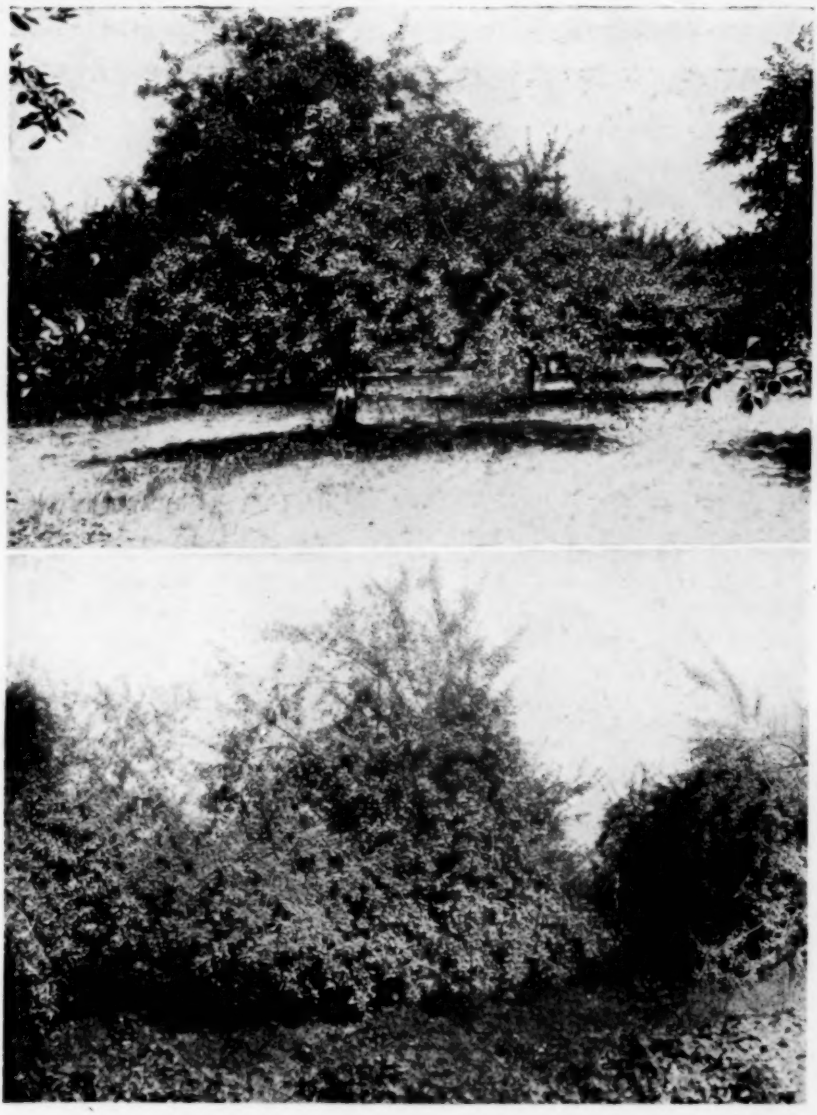
The grade of fish oil to be used is very important. Indications are that the darker, cheaper grades with high free fatty acid content do not give good results, due to the reaction possibly of the higher acid content with calcium to form a calcium soap. With the "Choice Light Pressed" grade, this possibility is eliminated. There may also be some slight difference between the Eastern Menhaden fish oil and the fish oil obtained on the Western coast.

The amount of fish oil used was based on Hood's conclusions; namely, for each pound of lead arsenate used in the tank add four ounces of the fish oil to the mixture. Under our conditions one quart of the fish oil was used to the 200 gallon tank generally but in some cases this amount was increased to a quart and a half. It was used by the various growers with satisfactory results with Bordeaux mixture, commercial lime-sulfur, Sherwin-Williams Dry Lime-Sulphur, New Jersey Dry Mix, Orchard Brand Kalinex, and in combination with plain lead arsenate and lime. The grade of fish oil used (less than 5% free fatty acid specified) proved apparently compatible in combination with the above spray mixtures, and no burning whatsoever was experienced. In all cases the adhesion of the spray was noticeably increased and this grade of fish oil appears to be the cheapest and most efficient sticker that can be used. It sticks the residue on over so long a period that it can be used with perfect

safety only in the early sprays, and this point has been emphasized on all occasions. There is no question but that indiscriminate use of this material late can greatly complicate our spray residue problem. However, it does appear to have a definite place in our early apple orchard sprays. When we are endeavoring to avoid the necessity of late cover sprays by completely controlling the first brood of Codling Moth we certainly need the best sticker available. Use of this material will unquestionably reduce the number of spray applications necessary. From our tabulated results during the past season it appears that the fish oil can be used with safety on late apples as late as June 25th during our normal season. At present after that date we are recommending that the usual caseinate spreader or supplemental dusting be used. Those growers having modern wiping or brushing machines can most probably use the fish oil slightly later. As brought out in a previous paper, there can be no question that the large interplantings of late, midsummer, and early varieties of apples with their different blooming and maturation periods constitutes a severe handicap to the Delaware growers in the problem of Codling Moth and Curculio control.

One of the most vital points in attempting to control an insect is the question of the proper equipment and manner of application of the spray. While the fish oil combination was used with various types of spray machinery such as the hand barrel sprayer, traction and power outfits, the most remarkable results were obtained in connection with its application with the Rex Liqui-duster on the property of Mr. J. Leonard Soper near Magnolia, Del. This grower used fish oil on 250 acres of apples, applying the sprays with several makes of power sprayers and the liquid duster. Due to the fine mist coverage obtained when using the liquid duster and the uniform amount of spray material applied, it is the writer's belief that the fish oil cannot be used where this type of application is employed as late as where the usual power outfit is indifferently and hurriedly used.

On one experimental ten-acre block, consisting mostly of Stayman and old-fashioned Winesap, the fish oil was used in the calyx and three cover sprays and the liquid duster was used to make all the applications. The cover sprays were applied May 23–24, June 25 and July 20th and fish oil was used at the rate of one quart to 6 lbs. of lead arsenate, twenty-five lbs. of hydrated lime, and 200 gallons of water. On this particular property scab has never been a problem. The accompanying photographs, taken October 8th, show clearly not only the wonderful sticking qualities of the fish oil during a very heavy rainy season but also bring



Views taken at random in the Soper orchard experimental fish oil block. Upper view, photographed July 20th, shows the coverage and residue remaining from the second cover spray applied June 25th. Lower view, photographed October 8th, shows the same from spray applied July 20th.

Representative clustr of Stayman apples from the Soper experimental block with one apple wiped clean for contrast. Last spray applied on July 20, 1928 with liquid duster; photograph taken October 8th. Note the apparent extension or fusion of the spray film maintained during growth of apple.

out the remarkable fact that in the above combination at least the film of spray residue seems to have extended or fused to keep the apple surface covered as the apple grew. This quality has been noted by others of the cooperating growers and if substantiated by further work with other combinations it is just the thing for which we have been searching. The heavy film coverage did not interfere apparently with the development or proper coloring of the fruit, as these apples reached full size and colored up normally. On this property there was a very noticeable reduction in the amount of "stinging" and wormy fruit at harvest this year over that of the previous five years. The residue, while sticking through the heaviest rains, comes off readily by wiping or brushing. All fruit from this entire property was run through the Andy Moe wiping machine and marketed without question.

The fish oil was used on 198 acres of grapes in the early sprays with excellent results during the past season. A good sticker and spreader appear to be especially essential with lead arsenate in the pre- and after-blossom grape berry moth sprays. The fish oil has given excellent results in these but the concensus of the cooperators is that this sticker should not be used on grapes in this section later than June 20th. If the clusters are thoroughly covered on the latter date, sufficient protection will be afforded to take care of the ordinary infestation. Where later applications appear necessary, caseinate spreader or fish oil soap can be used with far greater safety.

Fish oil was also used on peaches by two growers in a very limited way. One of these sprayed three acres in the shuck fall spray (May 29th) using 1½ pints of the fish oil in combination with commercial lime-sulfur 1 to 70, 6 pounds of lead arsenate and 15 pounds of lime to 150 gallons of water. Excellent results were obtained as the fruit from this block at harvest was remarkably clean in marked contrast to that from the adjacent block. Another grower used the fish oil in the shuck fall spray in combination with New Jersey dry mix and lead arsenate on one acre and reported excellent results.

MR. T. J. HEADLEE: I would like to inquire whether that experience with the arsenical residue met the requirements of the Bureau of Chemistry.

MR. H. L. DOZIER: I would state that this block showed about the heaviest spray residue in the State of Delaware this season. Samples of the heaviest sprayed fruit of the old-fashioned Winesap apple was submitted through our State Chemist to the U. S. Dept. of Agr. Food, Drug, and Insecticide Administration laboratory in Philadelphia, whose

report showed that these untreated apples taken on October 8th showed a residue of .025. Samples that had been run through the Andy Moe wiping machine showed .017 which was beyond the new tolerance. The texture and oiliness of the skin of the old-fashioned Winesap together with its average smaller size make this variety about the most difficult to clean by wiping and brushing of our varieties. Samples of the Stayman Winesap apple which had been run through the wiping machine and packed were then submitted and the report showed only .006 grains of arsenic oxide per pound of fruit, which is well under both the working tolerance for interstate commerce this year and the international tolerance. Fruit from the remainder of this property of over 350 acres with ordinary wiping was marketed without any question of over-residue. The experimental block was undoubtedly over-sprayed but it does show plainly the remarkable sticking and protective qualities of the fish oil. I do not think that there is any question but that this material can be used to good advantage in the early sprays. From our observations and work we do not think it advisable to use this material after June 25 on apples.

The fruit from this property was remarkably clean and the desired protection was certainly obtained. It may be that we may have to resort to use of the washing machines but this would mean a freezing out of many of our small growers and we hope and expect to avoid this.

MR. P. J. PARROTT: May I ask the speaker if in Delaware they have to make any provision for the control of apple scab. If so, what is the combination they use in connection with the fish oil and its compatibility?

MR. H. L. DOZIER: Yes, in Delaware we do have a scab problem and it is a big one. On this particular property of over 350 acres scab has never been a menace, due most probably to a large extent to thorough and very clean cultivation and so a fungicide is rarely used. The fish oil has been used in Delaware during the past season with Sherwin-Williams dry lime-sulphur, New Jersey dry mix, commercial lime-sulphur and Bordeaux mixture and is compatible with those combinations.

MR. P. J. PARROTT: Without injury?

MR. H. L. DOZIER: There has not been a single case of burning reported or observed.

MR. P. J. PARROTT: Have you ever seen any premature yellowing of foliage heavily coated with fish oil?

MR. H. L. DOZIER: No, none was observed. The trees bore a heavy crop of fruit and this colored up nicely under this coating of spray.

MR. P. J. PARROTT: This last year in Geneva we used fish oil in combination in treating our elm trees and on a number of trees where we made heavy applications we got noticeable yellowing during the summer months.

MR. H. L. DOZIER: Was the pure fish oil (with less than 5 per cent free fatty acid specified) used?

MR. P. J. PARROTT: That may be where the trouble was. We bought fish oil and I don't know what grade was used.

MR. H. L. DOZIER: The fish oil we used is the grade recommended by Hood in Massachusetts in his work, using it on shade and forest trees, namely, the "Choice Light Pressed" Menhaden oil, with less that 5 per cent free fatty acid specified.

MR. P. J. PARROTT: I will testify to the remarkable adhesiveness of it. We made our application in June and it showed from that time until late September when the trees appeared to have just about as heavy a coating as they did early in the summer. This was noticeably so with the shrubs and sidewalks.

MR. F. Z. HARTZELL: The material used at Geneva was the light pressed oil, the formula recommended. I would like to ask Dr. Dozier this question: I understood him to say he used fish oil with Bordeaux mixture in connection with grape berry moth. Is that right?

MR. H. L. DOZIER: Yes, in combination with Bordeaux mixture.

MR. F. Z. HARTZELL: How late and did you get rid of the spray residue?

MR. H. L. DOZIER: As an extreme I will cite the experience of one of our grape growers. In 1927 after several careless applications he realized that from the heavy infestation showing up late in June he would probably lose most of his crop, as was the case the preceding year. At my suggestion he used fish oil, in combination with Bordeaux, in an attempt to clean up the Berry Moth and prevent at least a heavy carry over as well as an attempt to save part of his crop, fully realizing that dipping might have to be employed. I left on vacation just before cutting time. When I came back I found that a good crop had been marketed without a murmur on the part of the dealers or anyone concerned. This same grower repeated a similar performance in 1928 using the fish oil out of necessity as late as July 8th. At cutting time traces of the residue remained but the crop was marketed without any "kick" on the part of the dealers. This represents the extreme and from the results of our preliminary work we do not believe the fish oil should be used any later than June 20th on grapes.

MR. F. Z. HARTZELL: What would be the advantage of the fish oil instead of the fish oil soap as used in berry moth control in the Lake Erie Valley?

MR. H. L. DOZIER: For one thing, there is nothing that can compare at present with it in cheapness.

MR. F. Z. HARTZELL: I mean leaving out the question of cost. The resin fish oil soap wouldn't stick quite so long and could be used a little later with less danger of spray residue, and I would consider it preferable for that mid-summer spray.

MR. H. L. DOZIER: For the mid-summer spray the resin fish oil soap could certainly be used with less danger of spray residue.

ADJOURNMENT: 4:20 p. m.

Saturday Morning Session, December 29

PRESIDENT W. B. HERMS: The first paper is by F. W. Poos.

LEAFHOPPER INJURY TO LEGUMES

By F. W. Poos, *Division of Cereal and Forage Insects, U. S. Bureau of Entomology*

ABSTRACT

A brief report on preliminary studies, during 1928, of leafhopper injury to legumes. Among the 15 species of Homoptera tested in cages on various legumes, only *Empoasca fabae* (Harris) caused the injury, which was serious on alfalfa, red clover, white clover, non-pubescent soybean, peanut, and sainfoin. The disease-like symptoms were not systemic. *E. fabae* free from the infectious principle has not been found to date. Plants not too badly injured always recovered their natural condition when the insects were removed.

This is a preliminary report which is based on observations made during 1928 at the Arlington Experiment Farm of the United States Department of Agriculture at Rosslyn, Va. The work was undertaken at the request of the Division of Forage Crops of the U. S. Bureau of Plant Industry.[1] In this paper attention is called to the importance of the injury which *Empoasca fabae* (Harris)[2] causes to certain legumes,

[1]This work was undertaken as a result of preliminary observations made by Dr. John Monteith, Jr., and Dr. E. A. Hollowell and carried on by them to a point where it was desirable to turn them over to an entomologist for more detailed and comprehensive study. Grateful acknowledgment is made to Dr. A. J. Pieters, acting in charge of the Division of Forage Crops of the U. S. Bureau of Plant Industry and to Dr. W. H. Larrimer, in charge of Cereal and Forage Insect Investigations, U. S. Bureau of Entomology, for making possible the work, for many helpful suggestions in regard to it, and for their criticisms of this manuscript.

[2]Thanks are due Dr. D. M. DeLong and Mr. W. L. McAtee for identifying all leafhoppers referred to in this paper.

especially to non-pubescent soybean, peanut, and sainfoin. Evidence is presented to show that this species is the only leafhopper among those tested which is responsible for this injury. It is hoped to arouse more interest in the field of the possible transmission by insects of disease-like injury of forage crop legumes, a subject which apparently has been neglected by entomologists, although several workers have hinted at possible disease relationships between leafhoppers and these legumes at various times during the past twenty years.

Various workers have referred to the injury which *E. fabae* causes to apple, bean, and potato, but little serious attention has been given to the relationship which this species bears to the injury to forage crop legumes until recently when Jones and Granovsky (*3*),[3] Hollowell, Monteith, and Flint (*2*), and again Monteith (*5*), and Granovsky (*1*) reported that this species was definitely responsible for the symptoms known as yellows or yellow top. These workers intimated that other species of leafhoppers were jointly responsible for the disease-like symptoms which they observed occurring under field conditions. During the past season a study of fifteen species of Homoptera, which were commonly found on forage crops in the field, was made in an attempt to establish definitely the responsibility among these insects for the injury to legumes and also to learn the possible extent of this injury to these crops, the most of which are commonly used for forage.

Below are listed fourteen species of leafhoppers and one tree hopper, together with the respective varieties of host plants upon which they were caged in order to study the reaction of these plants to these insects. Most of the tests were made in the insectary or greenhouse, although some were made only in field cages (Plate 4, Figs. 1 and 2). Suitable cages without these insects were always provided as a check in these experiments.

LIST OF HOMOPTERA AND THE HOSTS UPON WHICH THEY WERE CAGED DURING 1928 IN ORDER TO STUDY DISEASE-LIKE INJURY AND TO DETERMINE WHICH SPECIES CAUSE IT.

Agallia constricta Van Duzee:
Alfalfa, hairy Peruvian and Kansas; clover (red), Russian; clover (sweet), *Melilotus suaveolens;* clover (strawberry), *Trifolium fragiferum;* clover (zigzag), *T. medium;* cowpea, Whippoorwill; potato.

Agallia sanguinolenta (Provancher):
Alfala, hairy Peruvian and Kansas; clover (red), Michigan and Russian; cowpea, Whippoorwill.

Chlorotettix viridius Van Duzee:
Alfalfa, hairy Peruvian and Kansas.

[3]Reference is made by number (italic) to "Literature cited," at end of article.

Cicadula sexnotata (Fallen):
Alfalfa, hairy Peruvian and Kansas; clover (red), Michigan and Russian; cowpea, Whippoorwill; soybean, non-pubescent unnamed variety.

Deltocephalus balli Van Duzee:
Alfalfa, hairy Peruvian and Kansas; (clover red), Michigan and Russian; sainfoin (*Onobrychis viciaefolia*); soybean, non-pubescent unnamed variety.

Deltocephalus flavicosta Stal.:
Clover (red), Michigan.

Deltocephalus inimicus (Say):
Alfalfa, hairy Peruvian and Kansas; clover (red), Michigan; cowpea, Whippoorwill.

Deltocephalus sayi (Fitch):
Alfalfa, Kansas.

Draeculacephala mollipes (Say):
Alfalfa, hairy Peruvian; soybean, Dixie.

Empoasca fabae (Harris):
Alfalfa, hairy Peruvian and Kansas; bean, garden and mung; clover (red), Russian, Italian, French, and Michigan; clover (sweet), *Melilotus alba*, *M. officinalis*, and *M. suaveolens;* clover (alsike), *Trifolium hybridum;* clover (white), ladino and small resistant type; clover (zigzag), *T. medium;* cowpea, Whippoorwill; peanut (African); potato; sainfoin (*Onobrychis viciaefolia*); soybean, Dixie and non-pubescent unnamed variety.

Euscelis obscurinervis (Stal.):
Alfalfa, hairy Peruvian and Kansas; clover (red), Michigan and Russian.

Gypona octolineata (Say):
Alfalfa, hairy Peruvian; soybean, non-pubescent unnamed variety.

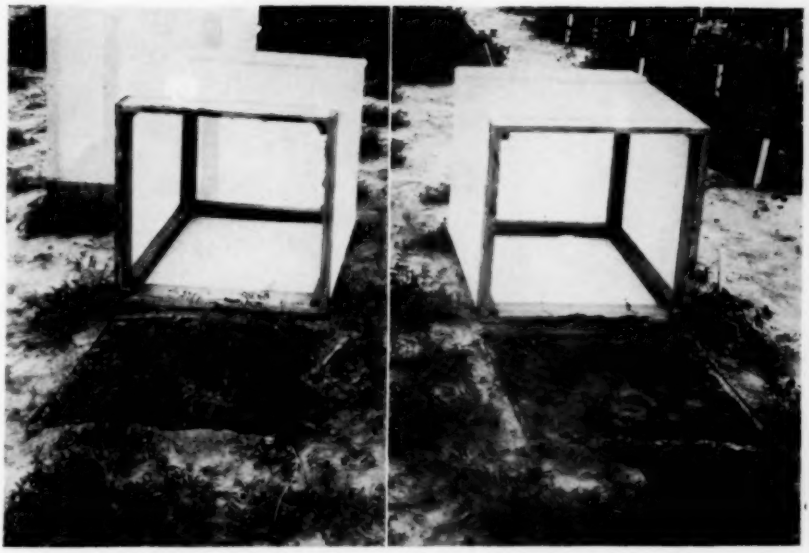
Kolla bifida (Say):
Alfalfa, Kansas; cowpea, Whippoorwill; soybean, Dixie.

Phlepsius irroratus (Say):
Alfalfa, hairy Peruvian and Kansas; cowpea, Whippoorwill.

Stictocephala festina (Say):
Alfalfa, hairy Peruvian and Kansas; clover (red), Michigan; clover (zigzag), *Trifolium medium*.

E. fabae was the only species that consistently caused the symptoms of yellowing and dwarfing to the plants upon which it was placed. No attempt is made here to give a detailed description of the injury produced by this species. The injury ranged from slight to serious on the various legumes listed under the name of this species. Plates 4 and 5 illustrate the importance of the injury produced by *E. fabae* on some of the legumes in field cages during the past season. In Plate 5, Figure 1, it will be noted that the soybean plants exposed to natural infestation were nearly as badly injured as those in the infested cage.

In general, the burning of the tip and margin of the leaves and a dwarfing and yellowing of all of the vegetative parts with resultant reduction in floral development are the common symptoms of this disease-like injury. The yellowing and reddening are more pronounced



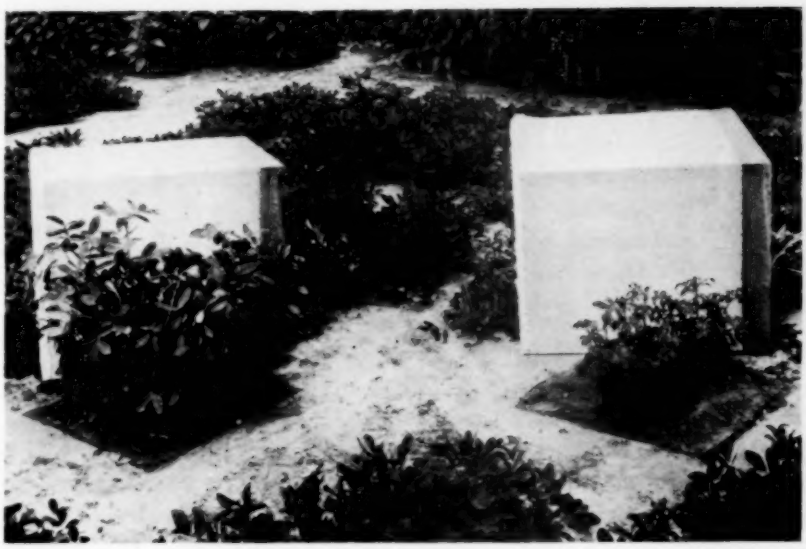


FIG. 1. Injury to sainfoin by *Empoasca fabae*. Cage at right had 400 adults from potato plants added July 19, 1928. Plants were all dead by Aug. 21, 1928. Cage at left had no *E. fabae* in it and plants grew normally.

FIG. 2. Injury to peanut (African) by *E. fabae*. Cage at right had 100 adults from potato plants added. Cage at left had *E. fabae* removed as often as practicable.

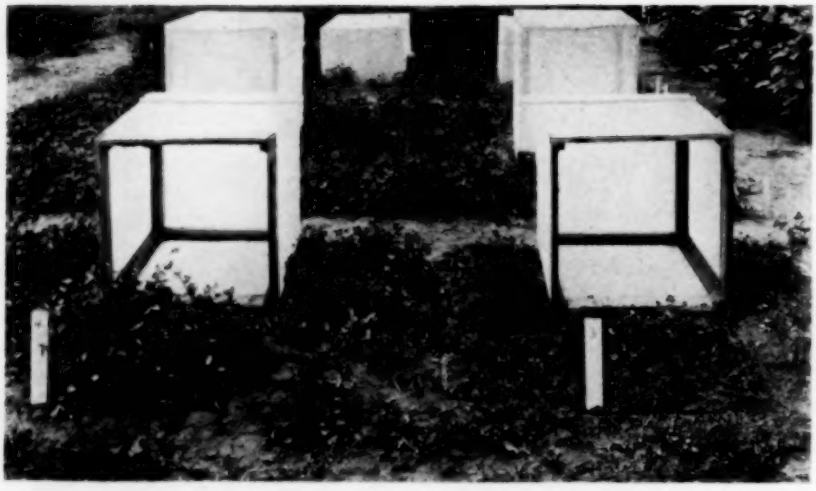


FIG. 1. Injury to non-pubescent soybean, Acc. No. 55069, by *E. fabae*. Cage at left had 400 adults from potato plants added. Cage at right had *E. fabae* removed as often as practicable. Note that plants exposed to natural infestation are injured nearly as much as those in the infested cage.

FIG. 2. Injury to French red clover by *E. fabae*. Cage at right had 200 adults from potato plants added. Cage at left had *E. fabae* removed as often as practicable.

in the red and white clovers, and the curling and crinkling leaves are more commonly found in cowpeas and soybeans. The injury to sweet clover, most varieties of cowpeas, and strongly pubescent soybeans was apparently only slight (not noticeable) during the past season in the field, whereas the injury to most of the other host plants, even if classed as appressed pubescent, was serious, especially when the plants were exposed to a concentrated infestation.

It should be stated that only adults were used in the experiments in which injury caused by the various species of leafhoppers was compared; also, that further tests with greater numbers of many of the species listed might show injury similar to that caused by *E. fabae*. In many of the experiments in the insectary and greenhouse a single individual leafhopper was placed upon a single seedling host plant about two inches in height. *E. fabae* consistently caused injury which killed the plants, whereas none of the other species caused any disease-like symptoms.

In the red clovers the amount of injury caused by the leafhoppers has been shown (*2*) to be correlated with the pubescence, the more pronouncedly pubsecent varieties of native origin being much the less injured. In the seedling stages, in cages during the past season, all varieties of red clover which were used, including some of native and some of foreign origin, readily succumbed to attack by *E. fabae* and no appreciable differences were noted in the period of time required to produce the fatal injury. The same was true in the comparison of Kansas alfalfa with hairy Peruvian alfalfa, both in the insectary and in the field. In considering the matter of control these facts would strongly suggest fall planting wherever possible. The matter of varietal resistance was observed in connection with twenty-five varieties of alfalfa which are being grown at Arlington Farm. The second crop was completely yellowed by *E. fabae* and many plants were apparently killed; the average height which the plants attained was about eight inches. Little difference in varieties was observed, although at times some of the varieties seemed to be yellowing somewhat faster than others. The non-pubescent soybean, however, experienced serious injury, both in the field and in cages which were infested with *E. fabae*, whereas the injury to the pubescent types of soybeans was not of importance. A variety of small white clover classed as non-pubescent remained green and in a thriving condition in the nursery during the summer when injury by the leafhoppers was most apparent in the nursery as a whole. However, when a few plants from this plot were caged with fifteen adults and two nymphs of *E. fabae* the typical disease-like symptoms soon appeared, and the plants were finally killed.

Yellow top of alfalfa similar to that caused by *E. fabae* was observed at West Point, Miss., early in October, 1928, by Mr. H. L. Westover, of the Division of Forage Crops of the U. S. Bureau of Plant Industry. Specimens submitted showed in addition to the yellow top much girdling by the feeding punctures of the nymphs of *Stictocephala festina* (Say), which were reported as being very numerous. Some adults taken from the yellowed alfalfa at West Point, Miss., were caged upon seedling plants of alfalfa and red clover in a greenhouse but the disease-like symptoms did not appear on these seedlings which were about two and one-half inches in height at the beginning of the experiment; these plants gradually grew larger though not so rapidly as those in the check cages.

In a new white clover nursery during October and November occasional leaves showed discoloration apparently identical with that which had earlier been caused by *E. fabae* on these varieties in another nursery at Arlington Farm. Careful examinations of these plots revealed no *E. fabae* or other leafhoppers, but each of the discolored leaves was infested with aphids,[4] the infestation by them being restricted almost entirely to the discolored leaves. Reddening of the leaves, similar to that caused by *E. fabae*, occurred on a variety of ladino clover in the greenhouse during November and December. The cause for this could not be definitely determined. Apparently no insects were involved.

Cause of Injury

As in the case of the hopperburn of potato, there is little doubt that the injury is caused by something more than mere mechanical injuries due to puncturing of the tissues and feeding therefrom. Hollowell et al (*2*) stated that several attempts had been made to isolate a causal organism from the browned portions of the red clovers but that no fungous or bacterial parasite had been found to be consistently associated with those particular symptoms. Monteith and Hollowell, of the Bureau of Plant Industry, in discussing the cause of injury in an unpublished manuscript, state, "The theory that appears most plausible on the basis of observations to date is that the insect when feeding injects into the tissue some chemical or enzymic toxin in a manner somewhat analogous to that found in plant gall-producing insects or in mosquitoes feeding on human tissue (not of malaria or other disease transmission). The observations of the past season would support this theory. The amount of injury produced by *E. fabae* was apparently directly proportional to the number of these insects which were present, other condi-

[4]Identified by Dr. A. C. Mason as *Illinoia pisi* Kalt. and *I. solanifolii* Ashm.

tions being similar. When *E. fabae* was removed from a slightly injured plant, the plant invariably recovered its natural growth. It was not possible to rear or collect any individual of *E. fabae* that was free from the infectious principle; however, nutrient solutions have not yet been tried for this purpose. In an attempt to do this, individuals of this species in the first instar were collected on such succulent plants as rhubarb and dock (*Rumex* spp.), which have not been observed to be noticeably injured by this leafhopper (although sometimes heavily infested), and transferred to seedlings of clover and alfalfa during October. In each case the usual injury was produced.

A transfer of *E. fabae* on host plants from garden bean to alfalfa, or potato to alfalfa, or alfalfa to clover and vice versa, or from cowpeas to alfalfa, clover, and soybeans, seemed to show no difference in the degree of the injurious symptoms or in the period of time required to produce them when these insects were again placed on seedlings of clover or alfalfa. In general, unless the injured plants were too nearly killed, all host plants recovered their normal condition after the *E. fabae* were removed from them. In view of the fact that the degree of resistance that has been shown in the legumes seems to be due to some character of the host plant, future investigations of the cause of injury will require an intimate knowledge of how and where *E. fabae* feeds in the plants and just what the effect of this feeding is on the tissues, as compared with the other species of leafhoppers under similar conditions. Tests for toxins may be required.

Experiments conducted for the purpose of comparing the capacity for injury by the various instars of *E. fabae* with that of the adult showed little difference in the type and degree of injury caused by the various stages. The period of time required to produce the injury on seedling alfalfa was apparently about the same for each instar except in the case of the first. These individuals usually molted to second instar before they were able to kill the single seedlings (about two inches in height) upon which they were placed. As stated by Granovsky (*1*) the disease-like symptoms were not found to be systemic, at least not in the sense that many virus diseases of plants are. In both alfalfa and clover, when shoots of the same plant, grown in 10-quart pails in the greenhouse, were caged separately with one cage containing *E. fabae* while the other was left as a check without these insects, the infested cage showed the typical injury whereas the plants in the check cage always grew normally.

Methods

Most of the field cages which were used were made of cheesecloth and were 2 feet square by 2½ feet in height, provided with an opening at the

top. A few cages were made of 30-mesh copper screen wire and were 3 by 3 by 3 feet with a door 18 inches square in the upper left-hand corner of one side. A suction method of handling the leafhoppers somewhat similar to that described and illustrated by Kunkel (*4*) and Severin (*6*) was used. For collecting large numbers of leafhoppers in the field and transferring them to field cages the apparatus illustrated in Figure 4,

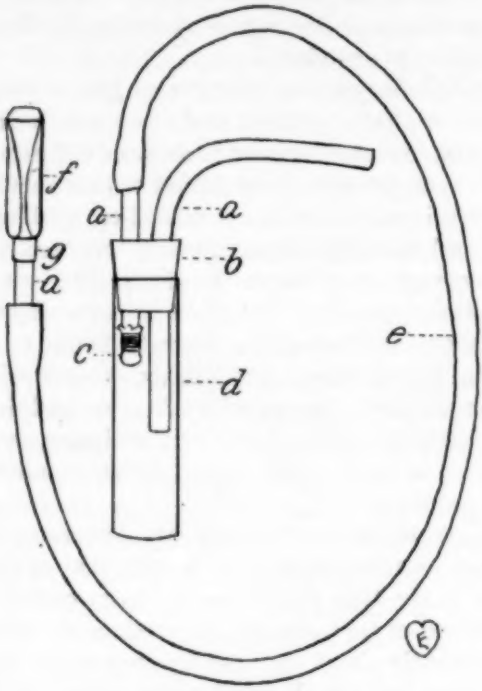


FIG. 4.—Apparatus used for collecting large numbers of leafhoppers and transferring them to field cages: *a*. Glass tubing, 5 mm. inside diameter. *b*. Rubber stopper snugly fitting glass vial, *d*, 1 inch in diameter and 4 inches in length. *c*. Silk bolting cloth covering end of glass tube, held in position by an elastic band, to form a screen in order to prevent the insects from being sucked into the collector's mouth. *e*. Rubber tubing, 6 mm. in diameter and 2 feet in length. *f*. Cigarette holder attached to glass tube by friction tape, *g*, permitting more continuous use of apparatus without tiring the collector.

was used. When *E. fabae* was abundant in the field, two to three thousand of these insects were transferred to field cages within a period of two to three hours by means of this equipment. After sweeping, the usual

method in collecting was to put the entire head into the net, sucking 100 to 200 individuals of the desired species into a vial before substituting an empty vial and repeating the process of collecting. There was no apparent injury to any of the leafhoppers, even to gravid females, when collected in this manner.

In the greenhouse and insectary various types of celluloid, cel-o-glass, and glass cages were used, the size depending largely upon the size and number of plants which were to be caged. For caging one or two small seedling alfalfa or clover plants from 1 to 3 inches in height, which were usually grown in 8-inch flowerpots, glass vials 1 inch in diameter and 5 inches in length and open at both ends were found to be satisfactory. One end was pushed into the soil deeply enough to hold the vial upright over the plant and the other end was covered with cheesecloth held in position by elastic bands; a cotton stopper covered with cheesecloth was often used satisfactorily. For larger plants celluloid or cel-o-glass was cut to the size desired, made into cylinder shape with the one end placed into the soil and the other covered with cheesecloth. In order to keep this type of cage intact, it was necessary to attach it to a wooden stake which could be pushed into the soil.

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Mr. C. C. Hamilton: I would like to ask Mr. Poos whether he tried any artificial injections from serum from the crushed leafhoppers similar to the method tried in Iowa on potato beetles.

Mr. F. W. Poos: I tried to emphasize in the paper this was merely preliminary work and we haven't tried that point, but hope to do it in the near future.

President W. B. Herms: The next paper is by Walter Carter.

THE PURPOSE OF PREDICTING OUTBREAKS OF *EUTETTIX TENELLUS* (BAKER) UNDER PRESENT-DAY CONDITIONS

By WALTER CARTER, *United States Bureau of Entomology*

ABSTRACT

There are three types of districts for which predictions of outbreaks of *Eutettix tenellus* might be worked out. Prediction for beet-growing districts located contiguous to breeding grounds is only a palliative, but of proven usefulness. Progress in disease-resistance work encourages industry to hold on in such territories. Prediction is very desirable for districts which receive their infestations as a result of migration from a distance. Location of centers of dispersal is the first essential step. Probabilities of insects reaching beet fields from these districts complicates the problem. In the third type of district, which also receives infestations as a result of long-distance migrations, the severe damage is very rare. There, the problem is principally agronomic and prediction of outbreaks of *tenellus* is not particularly relevant.

At the time of publication, in 1917, of Utah Station Bulletin 155 by E. D. Ball, the importance of the sugar-beet leafhopper (*Eutettix tenellus* Baker) to the sugar beet industry was fully appreciated. Since that time the insect has remained the limiting factor to the industry in the intermountain region. In addition, the relationship between the insect and disease in other truck crops has been established, consequently the desirability of predicting outbreaks, a method of avoiding losses first suggested by Ball in the above mentioned bulletin, is even more evident.

The condition of the sugar-beet industry at the present time, however, and the development of scientific work on the problem have led to a concept of the purpose of prediction under present-day conditions which includes several types of districts which differ not only as regards frequency of injury but also as to the source of the leafhoppers causing the damage. The viewpoint of the writer is that prediction service should be carried first to those factory districts which are in more or less constant danger, but which are endeavoring to maintain themselves. He is further of the opinion that once predictions are officially issued, they should be made an annual affair covering good, poor, and uncertain prospects.

Before proceeding to a discussion of the field concerned in the prediction of outbreaks, it might be well to consider the present condition of affairs with respect to the sugar industry in the States of Utah and Idaho which are, for the purpose of this paper, the two States most concerned. Great differences with respect to damage sustained exist in both States. North of Idaho Falls, damage due to curly-top is rare and it is doubtful

whether the disease has limited the industry in that district, at all. South of Idaho Falls to Pocatello and thence westward, the disease is of more frequent occurrence, but even in that district there is a noticeable increase as one proceeds west to the limit of beet growing, some twenty miles west of Twin Falls. The data obtained during the last four seasons have indicated with reasonable clearness that these variations in the severity of the disease are due to climatic differences which prevail in the areas mentioned and condition the maintenance of permanent breeding grounds of the leafhopper as well as the development of the disease.

In the State of Utah there are great variations between districts with respect to damage sustained. Box Elder County and Sevier Valley probably suffer losses more regularly than other districts of the State, but observations indicate that there are scattered localities throughout the State which are visited frequently. Cache Valley probably suffers less than any other district in Utah.

There are, therefore, in the States of Utah and Idaho, three types of district for which predictions might be worked out. One is that in which the territory contiguous to beet growing is not a permanent breeding ground and in which the beets often suffer as a result of migration of the insects from distant breeding grounds. Probably most of the State of Utah is in this class.

The second type, of which Cache Valley and the district of Idaho north of Idaho Falls are examples, is similar to the first in that it receives its infestations as a result of migrations from a distance but differs in that it suffers only rarely.

The third type is that in which the beet-growing districts are contiguous to permanent breeding grounds, the source of infestation, therefore, being definitely known. Such a district lies in the central portion of southern Idaho. As a matter of fact, the leafhopper's permanent breeding grounds extend from there, with little interruption, to the east slopes of the Coast Range in Oregon and Washington, but practically no beets are grown west of the Twin Falls, Idaho, Irrigation Project.

A consideration of the necessity for prediction in these three types of district, as well as of what is involved in such prediction will, it is believed, offer ample support to the viewpoint presented by the writer earlier in this paper.

The beet-growing district close to permanent breeding grounds is obviously the one in which damage can be expected to occur with greater frequency than elsewhere and it is in such districts that prediction of outbreaks is a real necessity. Such a district is to be found in

southern Idaho in three irrigation projects where superlative crops of sugar beets have been grown. The record for this district for the last ten years, however, is a sorry one, but the sorriest part of the record is the fact that the years of greatest damage have coincided with the years of greatest acreage, and it is this fact perhaps that has contributed more than any other to the present poor condition of the industry in that district. Prediction as to outbreaks of the leafhopper in such a district involves spasmodic beet culture which fits in better with the farmer's program than with that of the sugar companies which buy the beets. The experience to date, however, indicates that over a period of years far more beets will be grown with a prediction service than without one.

It might be argued that the prediction of outbreaks in such districts should be so simple as to make elaborate study with expensive equipment unnecessary; either the insect is present or it is not. The problem is complicated, however, where a large leafhopper population enters hibernation. The prediction to be of value must be issued not later than the end of February, and it is almost impossible to make any reliable estimate of populations in the desert districts during the winter. It becomes necessary, then, to study the environmental factors in very great detail so that even though the insect is inactive the probable success of hibernation can be estimated. It might also be argued that attempting to afford temporary relief to the industry in such districts where damage is frequent is hopeless and should be abandoned.

As far as direct control measures are concerned, this pessimism has some justification, but encouraging results have already been reported in the matter of obtaining disease resistant beets[1] and this progress towards a permanent solution is sufficient to justify any palliative measures which may permit the industry to hold on in valuable territory until complete success with a disease-resistant strain of sugar beets is achieved.

Predictions for districts which suffer as a result of migrations from a distance must necessarily be based on the same type of data as for the districts close to permanent breeding grounds. One is here reminded of the old cookery book which said "First catch your chicken." In other words, the first step is the location of the permanent breeding grounds from which the insect migrates. When an immense section lies open to suspicion this is obviously a tremendous task and one which will take considerable time. As evidence of this, Ball's Bulletin 155 reports

[1]Carsner, E. Resistance in Sugar Beets to Curly-Top. U. S. Dept. Agr. Circ. 388, 8p., illus. 1926.

work on the problem from 1903 to 1917 but leaves the matter of centers of dispersal for the State of Utah very much in doubt. Work was started, as part of the sugar beet leafhopper project, during the winter of 1926 in southern Utah and the data from the last two seasons encourage us to hope that some conclusion can be reached concerning the centers of dispersal before very long.

Assuming that the centers of dispersal are known with a reasonable degree of certainty, prediction of outbreaks in the far distant beet fields is then going to require not only an intimate knowledge of what is going on in the breeding grounds of the insect, but also a study of the factors which influence the flight to the beet fields. (A case is known in California where an enormous population of the leafhopper developed on the breeding grounds but the insects never reached the beets.) Such a problem appears to be well nigh insurmountable, but a very large district in Utah is subject to serious damage from flights of this kind, and intensive study on the problem is well worth while.

In a manuscript now being prepared for publication the writer has discussed the importance of a study of the environmental complex of an insect pest as an approach to the solution of the problem of its control. It may be possible through such a study to recognize ahead of time the type complex associated with the particular type of damage, if any, which will ensue. This means the consideration of all the factors in the environment susceptible of measurement and of the relation of biological phenomena to the data thus obtained. This is essentially what has been done in predicting outbreaks in the Twin Falls district, but even though certain factors in the complex may be of primary importance in the Twin Falls district, this may not prove to be the case farther south.

For districts like Cache Valley, it is doubtful whether prediction service will be of very much assistance. The fact is that there the limiting factors of beet culture appear to be principally agronomic. It is not without precedent that a district growing a large acreage of one crop continuously for many years should finally realize that rotation is good agricultural practice. The moving of the Cornish factory in 1927 was a recognition by the industry that there were too many mills in Cache Valley for the beet acreage available under a rotation program which is dictated by a lack of fertility and the presence of the sugar-beet nematode and root rots.

To summarize, then, there are, broadly speaking, three types of district in which predictions of leafhopper damage might be made.

1. Where the permanent breeding grounds are known and lie contiguous to beet-growing areas. Prediction in this case is a palliative only, but where the industry is endeavoring to maintain itself in such places it is of proven usefulness, and with the present progress on disease resistance its continuance is highly desirable.

2. Where beets suffer severely as a result of migrations from a distance. Predictions are desirable here also, but location of centers of dispersal is the first requirement; then detailed studies of these centers and of the probabilities of the insect reaching the beet fields.

3. Districts of occasional damage as a result of migrations from a distance. The reason for these occasional migrations is probably obscure and therefore difficult of determination. In these districts curly-top is not the limiting factor and therefore predictions of outbreaks of *tenellus* in these districts are not particularly relevant.

PRESIDENT W. B. HERMS: The next paper is by Walter Carter and R. G. Crawford.

EUTETTIX TENELLUS (BAKER) AS A FACTOR IN THE PRODUCTION OF NICOTINE FOR INSECTICIDAL PURPOSES

By WALTER CARTER, *Bureau of Entomology*, and R. F. CRAWFORD,
New Mexico Agricultural Experiment Station

ABSTRACT

In the summer of 1927 a peculiar diseased condition was observed in experimental plantings of tobacco grown as a source of nicotine at Albuquerque, New Mexico, which subsequently proved to be caused by the sugar-beet leafhopper *Eutettix tenellus* Baker. It was observed also that a native tobacco known locally as "poncha" was immune to the disease.

INTRODUCTION

On June 29, 1927, the New Mexico Agricultural College received a telephone call from the Consumers' Tobacco Company of Albuquerque, New Mexico, asking if it would be possible for the station pathologist to make a trip to Albuquerque to investigate a peculiar condition existing on the tobacco crop.

R. F. Crawford visited the tobacco fields on July 1, 1927, and found approximately 30 per cent of the plants to be badly stunted, dwarfed and the leaves curled. The leaves of the young plants were smaller, the leaf-petioles shortened, and the leaf blade reduced in length and width as well as being decidedly crinkled and puckered. At this time the trouble was confined entirely to the rustica tobacco, *Nicotiana rustica*, L. grown from Eastern seed, although later in the season a few plants of a burley variety showed the same symptoms. The plantings of rustica

tobacco were not in one block, but were scattered over a considerable area. The trouble was not confined to any particular field, but was generally distributed over the area in the vicinity of Albuquerque. The experimental plot of rustica at the college at Las Cruses, N. M., was entirely destroyed by the same trouble.

The disease made its appearance about June 20 and apparently did not spread to any extent after that date.

A large number of the diseased tobacco plants died early in the season, thus reducing the stand considerably. Other diseased plants remained stunted and dwarfed until the end of the growing season. Officials of the tobacco company stated that the nicotine content of diseased plants was lower than that of healthy plants.

Leafhoppers collected from the fields the latter part of June were identified by Dr. W. L. MacAtee, Biological Survey, U. S. Department of Agriculture as follows: *Agallia uhleri* Van D., *Euscelis exitiosus* Uhl., and *Deltocephalus* sp.

Diseased plants were taken to the College, the juice extracted and inoculations made on healthy plants for the purpose of determining whether the disease was subject to artificial inoculations. The results were negative.

Although none of the insects taken from the diseased plants were identified as *Eutettix tenellus* (Baker) the appearance of the diseased plants was so similar to curly-top symptoms on other plants that specimens of the diseased plants were sent to the Twin Falls Laboratory for test. Non-infective *Euttetix tenellus* were caged on these plants and removed from them to healthy beets. These beets developed typical symptoms of curly-top. The experiments were repeated with like results so that the trouble was thus definitely established as being due to curly-top.

The absence of *Eutettix tenellus* from the tobacco fields at the time the collections were made is not surprising in view of the inability of the insect to live very long on many plants that are susceptible to the virus which the insect transmits.

Both writers visited the affected fields in September, at which time much of the disease was in the advanced stage and the stand of tobacco very much reduced. In one field of rustica, however, no disease was observed, and the indications are that the date of planting in this case was responsible for absence of the disease.

Experiments were being conducted at that time on growing a native tobacco, locally known as "poncha" *Nicotiana* sp. This tobacco is the native Indian tobacco and has been grown by the Indians for a long

time. It was interesting to observe that not a single case of disease could be found on this tobacco. Plantings of both the rustica and "poncha" tobaccos were made at the Twin Falls, Idaho, laboratory from seed collected at New Mexico. Symptoms of the disease were obtained on the rustica tobacco by caging infective leafhoppers thereon, but the "poncha" plants remained healthy under the same treatment. In the spring of 1928, plants of both kinds were planted in an experimental plot out doors and infective leafhoppers caged on plants in such plot. A long period of cool, cloudy weather interfered with the developing of pronounced disease symptoms, but the rustica tobacco was the only one of the two types affected.

The behavior of the "poncha" tobacco gives the same indication as does the Red Mexican bean, and that is that crops grown for a long period of years in areas heavily infested by the sugar-beet leafhopper and curly-top are subject to vigorous natural selection with the result that they acquire very great resistance. The evidence thus far is that the "poncha" tobacco is immune. Further experimental work may result in positive results being obtained on this variety; however, it would seem that for practical purposes, its resistance is so high that it can be used with reasonable assurance of freedom from curly-top, even in badly infested areas.

Its nicotine content is satisfactory compared with rustica. This appears to be the only instance where the problem of *Eutettix tenellus* is ameliorated by the availability of a native crop having either very great resistance or immunity, and at the same time being suitable for the commercial purposes for which the crop is grown.

Dr. T. R. Eyer of the New Mexico station staff reported a very early migration of the leafhoppers in southern New Mexico last spring. This fact probably accounts for the freedom from curly-top which was experienced during the season of 1928.

PRESIDENT W. B. HERMS: The next paper is by L. C. Woodruff.

EUPELMUS POPA GIRAULT, A PARASITE OF THE SORGHUM MIDGE, CONTARINIA SORGHICOLA COQUILLETT

By LAURENCE C. WOODRUFF, *Cereal and Forage Investigations, Bureau of Entomology, United States Department of Agriculture*[1]

ABSTRACT

Early workers did not record *Eupelmus popa* as one of the parasites of the sorghum midge but it has now almost completely supplanted the others. The larvae show an

[1]The writer takes this opportunity to express his appreciation to Mr. C. H. Gable, under whose direction this work was begun, and to Dr. W. J. Phillips, for helpful suggestions during the preparation of the manuscript.

interesting specialization in feeding habits as many of them become phytophagous in their later stages. A few individuals of each generation enter hibernation and emerge the following spring. This behavior shows a remarkable adaptation to the development of the host.

In the course of recent studies *Eupelmus popa* Girault was found to be the most important factor in the natural control of the sorghum midge, although in some cases the parasite itself may cause injury to the grain. Its presence in the United States was not reported until 1922, when Gahan (3) recorded it as reared from the sorghum midge by C. H. Gable, at San Antonio, Tex. As several points in its life history are exceedingly striking, it seems desirable to record the available information even though somewhat incomplete.

The most interesting phase in the development of *Eupelmus popa* is its occasional habit of being both parasitic and phytophagous. Although such a relationship is unusual it is not unknown among the Chalcids, as the larvae of four species have been found to be parasitic in their early instars, and plant feeders in their later development. According to Neilsen (4), the larva of an undetermined species of Eurytoma devours the young larvae of *Cryptocampus angustus* Htg., and completes its development in the pith of willow stems which is the food of its host. Rimsky-Korsakov (8) records a similar habit for *Harmolita inquilinum* Rimksy-Korsakov in rye. Phillips has mentioned this sarco-phytophagy for *Eurytoma pater* Girault (5, p. 145) and for *Eurytoma parva* (Girault) Phillips (6, pp. 13–14), in their relations to the wheat jointworm. In a later paper (7) he gives an excellent account of this feeding habit for *E. parva*, the first detailed observation for American Chalcidoidea, suggesting (7, p. 743) that the majority of the American species of Eurytoma associated with the Harmolita may have similar life histories. Phillips (7, pp. 745 and 756) also thinks that, on the basis of the classification of American systematists, Rimsky-Korsakov's *Harmolita inquilinum* is, perhaps, a species of Eurytoma. The account of this feeding habit for *E. popa*, as herein described, is believed to be the first published record of such a relationship for the Eupelmines.

History and Origin

Mr. C. H. Gable was the first to observe *Eupelmus popa* in the United States. When he took up the investigation of the sorghum midge at San Antonio, Tex., in 1920, he found *E. popa* to be an important parasite and submitted specimens to Mr. A. B. Gahan, who identified them. Girault had described the species from the Dutch Antilles and stated that it was parasitic upon *C. sorghicola* on the island of Curacao. W. H.

Dean (1), who studied the sorghum midge during 1908 and 1909 in Louisiana and Texas, recorded the abundance of *Aprostocetus diplosidis* Crawford and of *Tetrastichus* sp., but failed to mention *E. popa*, whereas Gable found that the latter far outnumbered the combined total of the other two species present in 1920. Apparently *E. popa* either was introduced into this country after 1909 or it was present in such small numbers that it was overlooked by earlier workers. At present, however, it has increased to such an extent that the other parasites have been almost completely supplanted.

Since 1920 it has been found widely distributed throughout Texas, it has been collected at Columbia, Mo., and one female was found by the writer at Charlottesville, Va., ovipositing in midge-infested feterita heads during the summer of 1927. Specimens have also been received by the National Museum from Java and India.

It is difficult to determine whether or not this is a native species. The fact that its association with the midge has not been previously observed in the United States and that it apparently has no other recorded hosts may indicate that it is a recent importation. As such, it could easily have been brought into this country through shipments of sorghum seed. Although the original description of the species from an American locality might favor the supposition that it is a native insect, its host, the sorghum midge, is an old offender in Asia, and the parasite is well established there also. Nothing is known regarding the original habitat of the host itself other than its presence in the older countries where the grain sorghums and wild hosts have existed for an indefinite period.

Life History

The small, whitish eggs of *Eupelmus popa* are attached, singly, to the hairs on the inner glumes of a midge-infested spikelet. The egg is ellipsoidal in form with a pedicel at either end; one pedicel is nearly as long as the egg itself and the other about one-fourth as long. The longer pedicle may be folded back along the egg after oviposition, but is usually found extending away from the pole to which it is attached. The chorion is very delicate and elastic, with a smooth and shining surface. Of 26 eggs under observation, 24 hatched in approximately 18 hours and the other two failed to develop.

Upon hatching, the minute larva crawls among the glumes of the grain spikelet, seeking a midge larva on which to feed. The young parasite tears a hole in the body of the host with its mandibles, and feeds until the contents of its victim are exhausted. First-instar larvae seem unable

to puncture the skin of the host pupae, but these are readily attacked after some development of the parasite has taken place on midge larvae. In rare cases only will the parasite attack the hibernating larvae of the midge. The newly hatched parasite larvae are of a translucent-whitish hue but, after beginning to feed, they soon take on the reddish color of the host. This color is first noticeable only in the intestine of the larva, but spreads throughout the body as feeding progresses. There is no uniformity in the feeding habits of the larvae. Some may complete their development on only one host, others may require as many as three, and a few feed on the plant itself after having consumed at least one host. Phytophagy does not occur with every individual nor with the majority; in fact most of the larvae subsist solely on animal food. Where there is only one midge larva present in a spikelet it is often insufficient, and the parasite then completes its growth on the plant sap. Frequently, however, a parasite larva will consume a midge larva and then turn its attention to the sap of the plant, even though other stages of the dipterous host are present in the same spikelet. This certainly indicates that there is some impulse other than the lack of animal food that impels the parasite to change its diet to plant sap.

The evidence that some of the larvae of *E. popa* do feed on the plant itself, subsequent to their partial development as parasites, is conclusive. After the parasite larvae begin to feed on plant sap they lose their reddish color and change to the characteristic cream color of the prepupae and the overwintering larvae; through the body wall of the larva the milky sap of the developing seed can then be readily seen in the intestine. Often the larvae have been found lying imbedded in cavities, surrounded by the shredded plant material which results from the lacerations of the seed during the feeding period. These cavities are usually many times the size of the larvae, and in one instance the entire content of a seed had been shredded.

As pointed out by Gahan (2), this habit is probably a recent specialization among the Chalcids and is significant of an evolution in feeding methods. It appears that this parasite is feeling its way by gradually substituting plant for animal food and may eventually become independent of its host, the midge. The food requirements of the parasite and of the host are, doubtless, so very similar that such a change is not so radical as one might think. It is a reasonable assumption that *Eupelmus popa* is in an early stage of this transition, since plant food is not necessary for the completion of its development but is utilized only to replace the animal food in case of a shortage or at the apparent election of the individual after it has whetted its appetite by first feeding

on animal matter. All attempts to induce development on plant sap alone have ended in failure, but the parasite larva may turn to the plant juices if its partially consumed host is removed and the larva left on the developing seed. Assuming that this partial phytophagy is a subsequent development in the feeding habits of the Chalcids, we may perhaps say that *E. popa* is in a less advanced stage than are the four cases noted in the Eurytomidae, as the latter are dependent upon plant sap for a large part of their development.

Eupelmus popa is, without doubt, a primary parasite in its relation to *Contarinia sorghicola*, but it may also be a secondary parasite in that, during the process of its external feeding on the larvae of the sorghum midge, the internal parasites (*Aprostocetus diplosidis* and *Tetrastichus* sp.) may also be consumed. This is quite possible and highly probable, judging from the relative abundance of the internal parasites before and after the appearance of *E. popa*.

The larvae require from 6 to 12 days to complete their growth and pass through five instars, after which follows a short period of apparent rest before pupation. During this quiescent stage the larvae which have developed upon animal food lose their reddish color and become a uniform dusky yellow, whereas those which have fed on plant sap will have made such a change in color before the prepupal stage is reached.

The pupa lies approximately in the position which was occupied by the larva, with its head pointing toward the apex of the spikelet. Its color is a yellowish white at first, but darkens considerably before the adult emerges; this is especially true of the head and thorax, which becomes a greenish black. At the end of approximately six days the pupal skin splits and the adult is liberated, the cast skin remaining within the spikelet.

At the time of eclosion the majority of the adults chew a small hole, through which to emerge, in the side of the glumes of the spikelet. Two adults, both males, were observed by the writer to emerge from the tips of the spikelets, drawing the body free from the glume by pulling with the legs on adjoining spikelets. When free, the adult rests upon the grain head for several minutes, while thoroughly cleaning the body with the legs and mouth-parts. The wings are set in motion at intervals, apparently to assist in the drying. Males emerge first, and crawl actively over the head awaiting the appearance of the females. These copulate but once and then fly away. Although scattering numbers of adults appear throughout the day, the heaviest emergence occurs during the late morning hours. In the breeding cages used in the writer's experiments about equal numbers of males and females emerged.

About six days after the female midges have laid their eggs the adult females of *Eupelmus popa* begin ovipositing in an infested grain head. This interval allows the midge larvae ample time for growth before the hatching of the parasite eggs. The female midges begin ovipositing in the spikelets at the tip of the head, as they bloom, and work downward with the daily opening of the flowers; the parasites start at the tip of the head and progress downward in the same manner, so that a definite interval is maintained between the two oviposition periods. When once located on a midge-infested head, the female parasite apparently remains on that head for the duration of her life, or until eggs have been laid in all spikelets containing midge larvae. As many as seven females have been observed ovipositing within the spikelets of the same head without apparent interference, and sometimes several will oviposit in rapid succession within the same spikelet. The parasites start oviposition about 10 A.M., continue until about 6 P.M., and at night rest on the underside of the topmost leaves of the plant.

In searching for a spikelet containing a midge larva, the female parasite crawls actively over the grain head, tapping the apex of the glumes with her vibrating antennae. When a suitable spikelet is found, the female climbs to the tip, straightens her legs, arches the abdomen, and points the ovipositor between the glumes; the ovipositor is then released from its sheath and is driven into the spikelet as the abdomen is pulled down with the legs. In many cases the female is unable, at the first attempt, to force the ovipositor between the glumes, and takes up a new location after reexamining the tips of the glumes with her antennae. She usually repeats this process several times before locating the desired spot for the deposition, but only one egg is laid at a time in a given spikelet.

Three adults were observed to feed at intervals on the tips of the spikelets of a feterita head in which they were laying their eggs. The material on which they fed seemed to be the hairy tips of the glumes, that were bound together by a gummy fluid which was to be found only at this point on the spikelet. Both males and females have been observed to feed on the sweetened water supplied in the rearing cages, but such food did not seem necessary for activity.

The length of adult life, as determined under cage conditions, is brief. One female, confined in a glass cylinder cage containing a grain head suitable for oviposition, lived for nine days. A male lived for six days in a similar cage. The average longevity of females under these conditions is about 6 days, and that of males 3 days.

Under normal summer temperatures the time required for development from egg to adult ranges from 14 to 18 days, with an average of about 16 days. Lower temperatures during the spring and fall retard the development to such an extent that for the entire season the average length of a cycle is about 18 days.

Seasonal History

The seasonal development of this parasite, naturally, follows very closely that of the host. Emergence begins in the spring shortly after the first adults of the sorghum midge appear, and continues for several weeks, with varying numbers issuing from time to time. Successive life cycles occur from early spring until the development is stopped by severe frosts in the fall. Although these cycles overlap to such an extent that no well defined broods are apparent, ten consecutive generations have been reared in field cages during one season. The parasite follows its victim from one host plant to another, readily adapting itself to all conditions. As this parasite is rather slow to build up its number in the spring it does not quickly gain control of the sorghum midge, and it is only late in the summer that it materially affects the amount of damage in a grain field.

Eupelmus popa hibernates as a larva within the spikelet, and pupates shortly before the time of emergence. A small percentage of the larvae of each generation hibernate and carry the species over until the next year; the remainder of the larvae pupate and "carry on" throughout the season. In the spring the adults from these divers overwintering generations emerge at about the same time. This behavior shows a remarkable adaptation to the development of the host, as the pupariation of the sorghum midge occurs irregularly throughout the season. There are, also, some indications that the parasite may, as does the host, delay emergence and hold over until the second spring.

Conclusions

Eupelmus popa was first discovered in the United States in the summer of 1920 at San Antonio, Tex. Its presence has since been observed in Missouri and Virginia. When discovered it was well established, and it has now supplanted the other parasites of the sorghum midge, and taken first rank in effectiveness.

E. popa was probably introduced into America in shipments of sorghum seed from Asia, where it is known to be present.

Its larvae are occasionally both parasitic and phytophagous in habit. They normally complete their development on animal food alone, but may change to plant food in their later stages.

It readily attacks and consumes both the larvae and the pupae of the sorghum midge. It is a primary parasite in this relationship, but may also be a hyperparasite in so far as the internal parasites also are destroyed.

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PRESIDENT W. B. HERMS: The next paper is by D. J. Caffrey.

A GENERAL SUMMARY OF THE EUROPEAN CORN BORER SITUATION IN THE UNITED STATES AT THE CLOSE OF 1928

By D. J. CAFFREY, *Senior Entomologist, Division of Cereal and Forage Insects, U. S. Bureau of Entomology*

ABSTRACT

During the year 1928 the usual progress occurred in the adaptation of the European corn borer, *Pyrausta nubilalis* Hubn., to its new environment and in the solution of the biological and economic problems imposed by its presence in this country.

In the Great Lakes section, the known infested territory was extended to include a strip of townships from 10 to 30 miles in width, contiguous with the limits previously established. The results of the 1928 infestation survey in this section demonstrated either that a decided reduction in corn-borer abundance occurred in all districts where a satisfactory clean-up of the corn residues of 1927 was obtained or that the normal rate of increase was greatly reduced. Conversely, the absence of compulsory clean-up, or the inability to secure proper enforcement, resulted in pronounced increases of borer abundance.

The various research projects have shown encouraging progress during 1928, but have not revealed the necessity of any material changes in the recommended and demonstrated clean-farming methods of control.

A total of approximately 1,000,000 additional imported parasites were liberated in the field during 1928. Seven imported species of parasites have been recovered under such circumstances and in such numbers as to indicate their permanent establishment.

A review of the European corn borer situation in the United States at the close of 1928 reveals the usual progress during the past season in the adaptation of this foreign insect to its new environment and in the solution of the many biological and economic problems imposed by its presence in this country.

Spread During 1928

In the Great Lakes section, a spread of the pest to adjacent townships, in discoverable numbers at least, occurred at practically all points along the limits of the infested territory as known in 1927, to include a strip of new territory varying from 10 to 30 miles in width, as reported by Mr. L. H. Worthley, in charge of corn borer quarantine and control, of the Plant Quarantine and Control Administration. In this important western sector, specimens of the borer were discovered as far as the western border of Laporte County, Indiana—about 30 miles from the Illinois state line; to the southward as far as the southern limits of Fayette County, Ohio—about 50 miles from the Kentucky state line; to the northward in Mackinac County, Michigan; and to the eastward as far as the Connecticut River Valley in southern Vermont, in Massachusetts, and in northern Connecticut.

The spread from the two-generation area in New England was of little importance, except in eastern and southeastern Connecticut where the borer was discovered in a total of 23 townships adjacent to previously known infested territory.

Status of Infestation and Crop Loss

The Great Lakes Section. The annual survey to determine density of infestation, conducted in the Great Lakes section during the late summer and early autumn of 1928, demonstrated that throughout the greater portion of the infested territory the corn-borer population had increased to an appreciable extent. The increased numerical abundance of the borer was particularly evident in those portions of the territory where no organized clean-up had been attempted or where an effective clean-up was prevented by organized or passive opposition on the part of the less sympathetic farmers. These increases were more than offset by the tremendous decreases secured in the more heavily infested counties of Michigan (Monroe, Wayne, St. Clair, Sanilac) and Pennsylvania (Erie, Crawford), where excellent cooperation was secured in applying the recommended clean-up measures. Such decreases have affected the figures expressing general averages to such an extent that an examination of the results from the entire territory surveyed in 1928, as compared with the results from the entire territory surveyed in 1927,

indicates a reduction of 36.78 per cent in borer abundance for the entire territory surveyed in Michigan, Indiana, Ohio, Pennsylvania, and western New York.

The territory surveyed comprised practically all townships inside the "zero border", that is, where no borers were revealed in the standard examination of 500 plants in each of 5 cornfields per township. A total of 1,511 townships, involving 7,509 cornfields, were included in this survey.

The more important points developed during the 1928 infestation survey, as well as an indicative comparison with similar surveys during preceding years, are shown in the following tabulation:

TABLE 1. COMPARISON OF EUROPEAN CORN BORER POPULATION AND PERCENTAGE OF PLANTS INFESTED THROUGHOUT THE ENTIRE TERRITORY SURVEYED IN THE GREAT LAKES SECTION, AND FOR EACH STATE, DURING THE FOUR-YEAR PERIOD 1925 TO 1928, INCLUSIVE

State	Average percentage of plants infested				Total larvae per 100 plants			
	1925	1926	1927	1928	1925	1926	1927	1928
Michigan	1.10	3.70	8.90	5.07	1.50	10.73	26.71	11.22
Indiana	*	*	*	0.20	*	*	*	0.35
Ohio	1.48	2.17	1.89	3.07	1.90	5.40	3.81	6.49
Pennsylvania	1.28	1.92	3.92	0.45	2.66	6.59	10.50	0.82
New York (West)	1.56	3.18	2.39	2.88	4.48	7.00	3.87	5.26
Average	1.35	2.95	4.08	3.17	2.11	8.02	10.52	6.65†

*No survey.

†This average decrease is accounted for primarily by the tremendous decreases in borer population secured in the counties of Monroe, Wayne, St. Clair, and Sanilac in Michigan and in the counties of Erie and Crawford in Pennsylvania, where an effective clean-up was instituted.

Emphasis should be placed upon the point that the results of the 1928 clean-up, as indicated by the infestation survey, reflect very impressively the territories where compulsory clean-up was attempted and effectively enforced. In general, either a decided reduction in borer population occurred in all territories where a satisfactory clean-up of the 1927 corn residues was obtained, or the normal rate of increase was greatly reduced. On the other hand, the absence of compulsory clean-up, or the inability to secure proper enforcement on account of the attitude of the less sympathetic farmers involved, has been reflected throughout the greater portion of such districts in pronounced increases in borer abundance.

With the exception of a few early-planted fields of sweet or field corn in the older portions of the infested territories, no important economic

losses attributable directly to the corn borer were observed or reliably reported upon in the Great Lakes section during 1928. The losses observed, in the few fields concerned, did not in most instances exceed 10 to 20 per cent of the crop, although one field under observation in Michigan contained an average of 15 borers per plant and was cut for silage early in the season as a means of preventing what threatened to be a very heavy loss in grain production.

Undoubtedly the extent of economic loss in 1928, as in preceding years, has been lessened by the "clean-up" policy, or farm disposal of corn residues, practiced in nearly all districts since the presence of the insect was first detected. While this clean-up in some districts, left much to be desired from the viewpoint of thoroughness and scope during the early years when this method was adopted, and although it is still deficient as practiced in the more recently invaded districts, it has resulted in greatly reducing the borer population carried over from one year to another in the corn residues and other plant debris, thus limiting the natural increase in numerical abundance of the borer and restricting the amount of appreciable economic loss.

THE EASTERN NEW YORK DISTRICT. In the original district of infestation in eastern New York the survey of the central part of this district in 1928 showed an increase of 13.89 per cent in borer population when compared to a similar survey in the same or nearby fields in 1927. Maximums of 100 per cent plant infestations were recorded for the first time in this district during 1928, and commercial losses estimated as ranging from 5 to 25 per cent were suffered in a few fields of early sweet corn in the oldest infested portion of the district.

A general infestation survey of the entire eastern New York district, inside the "zero border," was conducted for the first time in 1928. A total of 116 townships were included in this survey, involving a total of 570 cornfields. There were 9.02 per cent of the corn plants infested, on an average, in this group, with an average of 14.60 borers per hundred plants in the samples examined. The absence of similar surveys prior to 1928 renders it impossible to draw comparisons with conditions existing in former years.

THE NEW ENGLAND DISTRICT. During 1928 a decided increase in intensity of infestation developed in the southern portion of the two-generation district in New England, particularly in extreme southern Massachusetts and in Rhode Island. For the last two or three years the absence of clean-up laws in Rhode Island has resulted in a rapid increase of borer population in the eastern portions of that state, directly affecting

the situation in the adjacent area of Massachusetts. This important source of reinfestation, plus favorable weather conditions for the borer during its two oviposition periods, has resulted in the development of an infestation in southern New England which in many respects closely approaches conditions existing during the peak of the outbreak in 1922. In addition to field and sweet corn, severe infestations were observed in potato, beet, lima bean, pepper, and dahlia; as well as in the more susceptible weeds. Limited infestations also occurred in celery, green beans, sunflower, aster, and gladiolus.

Status of Research Activities

The various research projects pertaining to mechanical control, cultural practices, behavior, general and special biology, physiology, chemotropism, parasites, insecticides, host plants, etc., have made encouraging progress during the past season but no definite information has been obtained which would lead us to change materially the recommended and demonstrated methods of control through the medium of clean farming practices. This occasion is taken to contradict the idea sometimes expressed by misinformed persons that no control measures have been developed for the European corn borer or that, when properly applied, the application of the recommended control measures involves excessive costs.

President W. B. Herms: The next paper is by J. S. Houser and L. L. Huber.

NUTRITION AS A FACTOR IN THE RESPONSES OF THE EUROPEAN CORN BORER

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Abstract

This paper calls attention to the growing recognition of the fact that European corn borer, *Pyrausta nubilalis* Hubn., abundance is greatly determined by the growth condition of the host. The various responses of the insect, such as the rate of spread, the rate of accumulation, the seasonal fluctuation in population and the ultimate saturationpoint are influenced by the physico-chemical processes of the corn plant.

Statistical studies of data secured in Ohio and elsewhere show that the responses of the European corn borer are greatly influenced by the date of planting and the variety employed. This is interpreted to mean that the physico-chemical processes of the corn plant or the nutrition factor plays an important role in the determination of corn borer populations. This factor is of special importance to the moth in that the adult is able to differentiate not only between corn and other crop plants but also between growth condition of corn. Moreover, the nutrition

factor greatly influences the rate of larval establishment and survival. Whether each instar has particular food requirements has not been determined but it is possible that this is true. Likewise many other details of this relationship are not yet demonstrated but the lack of information does not affect the principle involved. On the basis that this relationship is a fundamental one certain theories, assumptions and statements of facts concerning the spread, accumulation, fluctuation in abundance, and saturation seem to be pertinent at this time.

One of the questions which has been of great interest to corn borer investigators is that which deals with the rate of spread of the insect. The theory that the direction and velocity of prevailing winds has largely determined the rate of spread is the most widely accepted. It can be conceded at the outset that the rate of spread is probably influenced by a number of factors. The fact that the average rate of spread toward the corn belt has been less rapid than in other directions has added considerable weight to the possibility that the prevailing southwestern wind of western Ohio thru June and July has been the main factor involved. A careful study of the possible influence of this factor in other parts of the infested areas of North America, however, has not always revealed this same relationship. Moreover, the wind theory does not offer a satisfactory answer to the fact that the difference in the annual rate of spread has varied more than the difference in the direction and velocity of the wind. Why, for example, was the spread in 1927 unprecedented in extent and that of 1928 relatively small? The writers believe that the nutrition factor is one which deserves joint consideration with wind. Since moths are attracted more strongly to the best corn it would appear logical to assume that if the fields of good corn were widely separated the moths would necessarily fly greater distances to satisfy their reproductive urge, for the fulfillment of this urge is imperative for the success of the species. Fields of good corn in Pennsylvania and eastern Ohio are relatively few as compared with those in western Ohio and Indiana. Furthermore, these fields are not only fewer in number but are much smaller. In this same connection it will be remembered that the corn crop at the period of moth flight in 1927 was realtively poor as compared with that of 1926 and 1928. The greatest spread in Ohio occurred in the year when the corn was poorest, indicating again that the quality and quantity of corn affects the behavior of the moths.

Relative to the accumulation of the corn borer it has also been a notable fact that the insect accumulates more rapidly in some habitats

than in others. In former papers by the junior author, C. R. Neiswander, E. N. Transeau, H. C. Sampson, and G. W. Conrey it has been pointed out that vegetation and soil types are indices of such habitats. Fundamentally, however, the major factor was that of the quantity and quality of corn in the various habitats. Where the nutrition factor is optimum, other factors being equal, not only the greatest number of moths are found but also the rate of larval survival is highest. In such habitats the insect accumulates most rapidly.

Another question concerning which there has been considerable discussion and much difference in opinion is that which involves the causes of the annual fluctuation in abundance. Experimental evidence covering a period of five years has shown rather conclusively that the annual fluctuation in population may be due in large measure to the nutrition factor. It is a generally observed fact that there may be a wider variation in the responses of the corn plant from year to year than in the behavior of the insect. Moreover, acceleration or retardation in the stage of development of the corn crop is not necessarily paralleled by an earlier or later appearance of the adults. For example, in 1927 moth emergence was relatively early, while corn development was greatly delayed, a circumstance that further increased the resistance of the environment in as far as the nutrition factor was concerned. In 1928 there was more complete synchrony than in 1927 between the behavior of the insect and the development of the corn plant, due in large measure to the fact that corn planting was about two weeks late in 1927. As a partial result of this more harmonious relationship in 1928 there was a marked increase in total borer population. It is to be recognized too that not only was the quality of corn in 1928 superior to 1927 but the quantity of such corn was much greater. The relationship between the nutrition factor, as indicated by the quantity and quality of corn, and total borer populations is considered as a very important one.

Finally, altho everyone is interested in the annual spread, fluctuation, and accumulation of the insect there are other questions which are of perhaps still greater moment. When will the biotic potential of the insect equal environmental resistance or when will the saturation point be reached? Where will it be attained first and what will be the level of population? The answer to these questions would involve not only a fairly thoro knowledge of all the biotic and physical factors but would lead into the realm of prediction. The writers do not propose to enter this field at the present time. It is their purpose rather to point out that inasmuch as spread, fluctuation and accumulation are influenced by nutrition it is logical to assume that, other factors being equal, the

ultimate level of population in any habitat will depend to a great extent upon this same factor.

PRESIDENT W. B. HERMS: The next paper is by L. H. Patch.

SOME FACTORS DETERMINING CORN BORER DAMAGE

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ABSTRACT

This paper reports the results of observations and experiments conducted on the European Corn Borer, *Pyrausta nubilalis*, near Sandusky, Ohio, during the summers of 1927 and 1928.

In experiments with six varieties of corn planted on five different dates, a high positive correlation was found between the height of corn and the number of egg clusters laid, indicating that the fields of sweet corn, usually planted earlier than field corn, and the earliest plantings of all corn fields usually bear more egg clusters because of the greater height of such corn. One year's results indicate that the corn borer moth shows a preference for corn of very early maturity and of about average height or taller. Next in preference is the variety or type that is tallest throughout the oviposition period of the moth. altho such variety is rather late in maturing. Short varieties, altho early in maturing, and varieties late in maturing and that are relatively short during the early part of the oviposition period receive the fewest egg clusters.

Borers hatching on corn planted on June 1 have as good a chance to survive and reach maturity as those hatching on corn planted earlier.

Significant differences were found between the survival of the borer on the large dent corn varieties Red Cob Ensilage and Leaming, with survivals of 25.6 and 28.4 per cent, and the survival occurring on the sweet corn varieties Red Evergreen and Golden Bantam, on the early maturing variety Northwestern Dent, and on the Flint type of corn, with survivals of from 35.3 to 44.7 per cent.

The average percentages of survival on all the varieties were 35.6 and 34.0 for 1928 and 1927. Such high survivals give a new appreciation of the reproductive powers of the corn borer.

Considering all the corn fields examined in the northern townships of Ohio where the dates of planting were accurately known, the European corn borer population during the five years from 1924 to 1928 has been consistently greater in the earliest plantings than in the later plantings. The borer population in field corn has averaged 47 per cent more in the earliest or first week's plantings than in those of the second. The borer population in sweet corn has averaged 65 per cent more in the plantings from April 15 to May 10 than in the plantings from May 11 to May 20. In the vicinity of Sandusky, Ohio, during the six years from 1923 to 1928, the corn borer population has averaged 5 borers in sweet corn to every 1 borer found in an equal number of stalks of field corn. A total of nearly 200 fields of sweet corn and 300 fields of field corn were examined during the six years. The questions arise as to whether these differences in borer population and the resulting differences in damage are due to a

decided preference for sweet corn by the borer moth, are due to an advantage in survival which the corn borers hatching on sweet corn have over those hatching on field corn, are due to some advantage which the early hatching borers have over those that hatch later, since sweet corn is generally planted earlier than field corn, or are due to a preference for the earliest plantings by the moth because such plantings are either more mature or are the tallest.

It has seemed desirable to determine, also, the maximum average number of living borers per acre that could be left in the surface debris of cornfields after clean-up or farm disposal without resulting in material damage to the succeeding corn crop.

Two series of experiments were started in the spring of 1927, one to determine the amount of damage caused to the corn crop by different average borer populations, and the other to study the causes for the differences in borer populations in different types and varieties of corn planted on the same and different dates.

Oviposition in Relation to Date of Planting and Variety

Plantings of each of six varieties of corn were made on April 20, May 4, May 18, June 1, and June 15, 1928. The May 4 and June 1 plantings were in duplicate. There were 7 rows of plots and each of the 6 varieties occurred once in each row. Each plot consisted of 10 rows of corn with 9 hills of 3 stalks each per row. The relative position of the plots is indicated on page 127.

A total of 630 plants of each variety were examined for egg clusters. The total number of egg clusters laid and the average height during the oviposition period of the corn upon which the clusters were laid are given for six plots of corn planted on each of the following dates: April 20, 388 clusters, 49 inches; May 4, 361 clusters, 47 inches; May 18, 229 clusters, 38 inches; June 1, 117 clusters, 30 inches; and June 15, 23 clusters, 18 inches. The height of the corn was taken to the bend of the topmost leaf.

It appears clear that height of corn, or a factor such as maturity correlated with height, is the chief factor in the selection of corn by the moth for oviposition. When the 42 plots of the experiment were classified according to variety, the height of the corn was found less for each successively smaller number of clusters laid for 80 per cent of the plots. Also, when the height of the corn of each of the 42 plots was compared with the number of egg clusters laid upon them, a positive correlation coefficient of .88 was obtained, showing a rather close correlation.

If the plots are classified according to variety, and the total number of egg clusters laid during the entire oviposition period on the 6 plots of

TABLE 1. NUMBER OF EUROPEAN CORN BORER EGG CLUSTERS LAID ON CORN OF DIFFERENT HEIGHT AND VARIETY BETWEEN DIFFERENT DATES AT SANDUSKY, OHIO, DURING 1928

		Period of Oviposition							
	Average	June 28 to July 6		July 7 to July 15		July 16 to July 25		Entire Period	
Variety of Corn	Silking Date 1928	Average Height	No. Egg Clusters	Average Height	No. Egg Clusters	Average Height	No. Egg Clusters	Average Height	No. Egg Clusters
Northwestern Dent.....	July 17	25.8	113	37.1	153	52.1	50	39.0	322
Leaming Dent.....	August 1	27.8	86	42.4	148	68.0	54	47.9	296
Flint.....	July 30	25.2	68	37.1	131	56.3	62	40.8	264
Red Evergreen—Sweet...	July 31	24.9	69	37.3	121	55.4	63	40.2	262
Golden Bantam—Sweet..	July 23	22.6	57	33.2	114	46.1	43	34.4	220
Red Cob Ensilage.....	August 3	23.2	55	37.1	108	62.6	41	43.0	209
Averages.....	July 28	25.0	75	37.4	129	56.7	52	40.9	262
Totals.....	———	——	448	——	775	——	313	——	1,573

each variety of the first 4 dates of plantings are considered, it is seen from Table 1 that height of corn is correlated with the number of egg clusters for the varieties Leaming, Flint, Red Evergreen, and Golden Bantam. But Northwestern Dent, a variety about average in height, bore the most egg clusters and Red Cob Ensilage, a tall variety, the least of all.

G.B. May 4–No. 1	R.E. May 4–No. 1	N.W. D. June 1–No. 1	L. May 18	F. June 1–No. 1	En. Apr. 20
37	53	25	29	23	52
L. June 1–No. 1	N.W. D. May 18	G.B. June 1–No. 1	F. Apr. 20	En. June 1–No. 1	R.E. June 15
24	57	13	65	14	1
N.W. D. June 15	F. May 18	L. Apr. 20	R.E. May 4–No. 2	En. June 15	G.B. May 4–No. 2
7	44	70	64	5	73
N.W. D. May 4–No. 1	L. May 4–No. 1	En. May 4–No. 1	R.E. Apr. 20	G.B. May 18	F. June 15
44	51	44	81	48	5
G.B. June 1–No. 2	N.W. D. Apr. 20	R.E June 1–No. 1	F. May 4–No. 2	En. May 18	L. June 15
14	85	20	76	22	3
R.E. May 18	F. June 1–No. 2	G.B. June 15	En. May 4–No. 2	N.W. D. May 4–No. 2	L. June 1–No. 2
29	14	2	64	75	23
F. May 4–No. 1	G.B. Apr. 20	En. June 1–No. 2	R.E. June 1–No. 2	L. May 4–No. 2	N.W. D. June 1–No. 2
42	35	13	15	99	36

Relative position of plots of corn used to determine oviposition habits of European Corn Borer moth, Sandusky, Ohio, 1928. Varieties of corn are indicated with the dates of planting of the plots as follows: G. B.—Golden Bantam, R.E.—Red Evergreen, N.W. D.—Northwestern Dent, L.—Leaming Dent, F.—Flint, En.—Red Cob Ensilage. The numbers below the lines indicate the number of egg clusters laid on the 30 inner hills of the 90-hill plots.

Based on 12 comparable variables the average number of egg clusters laid on a single plot of 90 stalks was 66. The probable error of the average was ± 11.3. Owing to the great variability in the number of egg clusters laid on the individual plots additional data must be obtained before reliable conclusions can be made in regard to the significance of

the differences in the number of egg clusters laid on the different varieties. By the use of Student's Method (1) a significant difference is indicated between the number of egg clusters laid on the variety Red Cob Ensilage and the varieties Northwestern Dent, Leaming, and Flint, and between the variety Northwestern Dent and the varieties Flint, Golden Bantam, and Red Cob Ensilage.

The Northwestern Dent variety, which was about 2 inches less than the average height, was 11 days earlier than the average in silking. The average date of silking for the April 20 and May 4 plots of this variety was July 11, and for the same plots of the other five varieties was July 22. The average date of silking for the May 18 and June 1 plots of Northwestern Dent was July 23, and for the same plots of the other five varieties was August 6. Since the May 18 and June 1 plots of Northwestern Dent were near or in the silking stage during the egg laying period and the same plots of the other five varieties were not, the preponderance of the egg clusters laid on Northwestern Dent should be found on the May 18 and June 1 plots, if the early maturity of Northwestern Dent attracted the moths to it. This was found to be the case to an extent. Ninety per cent of the excess of the number of clusters laid on Northwestern Dent over the average number laid on Leaming, Flint, and Red Evergreen, were laid on the May 18 and June 1 plots. Thus the very early maturity and the height of Northwestern Dent probably is the reason for the large number of egg clusters laid upon it.

Also, it may be seen from Table 1 that from July 16 to July 25 more egg clusters were laid on Flint and Red Evergreen than on Northwestern Dent and Leaming, which was not the case from June 28 to July 15. Ninety-five per cent of the excess of the average number of egg clusters laid on Flint and Red Evergreen over the average laid on the other four varieties were laid on the April 20 plantings of Flint and Red Evergreen. Since these plantings of Flint and Red Everegreen came into tassel and silk from July 16 to July 25 before the variety Leaming, and since the height of Flint and Red Evergreen was somewhat greater than the height of Northwestern Dent, the influence of maturity and height probably attracted more moths to Flint and Red Evergreen.

The Leaming, which was the tallest of the varieties throughout the oviposition period, was second to Northwestern Dent in the number of eggs laid upon it, probably because its height attracted the moths. This variety was next to the latest in maturing.

The varieties Flint and Red Evergreen were in silk on nearly the average time on the same date, and both were about average in height throughout the oviposition period, and both received about the average

number of clusters laid on the six varieties throughout the first two-thirds of the oviposition period.

The variety Golden Bantam, which produced the shortest stalk, altho silking 5 days earlier than the average, received with Red Cob Ensilage the least number of clusters throughout the entire oviposition period. This probably was because any possible attractiveness for the moths on account of its early maturity was neutralized by its shortness.

The variety Red Cob Ensilage, altho second in height during the last half of the oviposition period, received with Golden Bantam the least number of egg clusters throughout the oviposition period. Oviposition on this variety was least of all the six varieties both in 1927 and 1928. In 1927, altho the tallest variety, oviposition on it was 28.1 per cent less than the average for the other five varieties, and in 1928 was 31.9 per cent less. The fact that this variety was one of the least in height during the first half of the oviposition period, and was the last to mature, probably explains why the smallest number of clusters were laid upon it.

Thus it appears that when different types of corn are planted together the height of the corn has the greater influence in attracting the moths to lay their egg clusters, and that the early maturity of the corn predominates in attracting the moths only when the corn is of about average height or taller, and when such corn is near or in the silking stage and other plantings of corn are not. Differences in the maturity of varieties of corn probably have no effect in attracting the moths when all the different varieties are near or in the silking stage during the oviposition period. Early maturing varieties of about average height or taller when planted late are most effective in attracting the moths when compared with later maturing varieties planted on the same date. The corn borer moth shows no particular preference for sweet corn varieties.

Survival in Relation to Date of Planting and Variety

The same plots as were described in the preceding section were used to obtain the necessary data on the relation of survival to date of planting and variety. Each plot consisted of 90 hills of 3 plants to the hill. The egg clusters on the 30 inner hills of each plot were counted and tagged at least once every 5 days. It was assumed that as many young borers would migrate to the hills examined as would migrate away from them.

Since a four-year average for the average number of eggs per cluster is 15.18 ±4.73, this number was multiplied by the number of clusters to obtain the probable number of eggs laid on the plots. Exclusive of the June 15 plantings, the probable number of eggs laid on the plots averaged 664 and ranged from 197 to 1,502. The mature, or nearly mature,

borers were cut out and counted from the plants from August 20 to August 31 before migration in numbers away from the plants occurred. Table 2 gives the per cent survival, or the percentage of young borers growing to maturity, for each plot of the first four dates of planting for 1928. The data for 1927 are also given.

A large variation in per cent survival is noted for the individual plots. In 1927 an average per cent survival of 32.1 was found for 24 groups of 9 stalks each upon which an average of 392 eggs were laid. The three varieties to which the 24 groups were planted showed no significant differences in corn borer survival, and the number of eggs laid on any group did not differ excessively from the average for the 24 groups. The probable error of the average per cent survival for a single group is ±5.48. For 5 groups upon which about 2,000 eggs were laid the probable error of the average would be reduced to ±2.45. This shows the necessity of working with large egg samples to obtain reliable survival data.

TABLE 2. PER CENT SURVIVAL FOR THE EUROPEAN CORN BORER FOR SIX VARIETIES OF CORN ACCORDING TO PLANTING DATE

	Per Cent Survival Variety of Corn						
Planting Date 1928 Data	Golden Bantam	Flint	Red Evergreen	Northwestern Dent	Learning	Red Cob Ensilage	Average of all Varieties
April 20	41.9	23.0	51.7	40.1	22.7	29.3	34.8
May 4—No. 1	49.5	52.6	35.9	38.7	32.0	21.5	38.4
May 4—No. 2	30.5	57.2	30.8	29.8	27.7	30.9	34.5
May 18	58.9	41.9	32.8	37.3	31.0	22.2	37.3
June 1—No. 1	59.1	27.4	40.0	28.5	34.5	13.1	33.8
June 1—No. 2	44.0	40.5	33.5	34.4	19.4	36.8	34.8
Average of all Dates 1928	47.3	40.4	37.4	34.8	27.9	25.6	35.6
1927 Data							
May 2	38.6	38.7	54.2	44.5	36.5	33.5	41.0
May 7	35.3	26.2	29.0	29.3	23.7	17.6	26.9
Average of 1927 Dates	36.9	32.5	41.6	36.9	30.1	25.6	34.0
Average of all Dates 1927 and 1928	44.7	38.5	38.5	35.3	28.4	25.6	35.2
Probable Error of Average	±2.52	±2.90	±2.26	±1.43	±1.49	±1.98	±0.88

The average difference in per cent survival between the 6 plots planted on April 20 and the 12 plots planted on May 4 is 1.65 per cent in favor of the May 4 plots. According to Student's Method (*1*) (*2*) (*3*) (*4*)

(5) the odds are only 1.65 to 1 that the difference is significant. The average difference between the April 20 and May 18 plantings is 2.5 per cent in favor of the May 18 plantings, and the average difference between the April 20 and June 1 plantings is 0.5 per cent in favor of the April 20 plantings. Also the average difference between 12 pairs of plots planted on the same dates is only 1.4 per cent. Since the average differences in survival between plots of corn planted on different dates is practically no greater than the average difference between plots planted on the same dates, the difference in survival on corn planted on different dates can hardly be called significnat. Thus a borer hatching on corn planted May 4, or May 18, or June 1, has as good a chance to survive as one hatching on corn planted on April 20. Also, since the average silking dates of all the varieties planted on April 20, May 4, May 18, and June 1, are July 20, July 22, August 1, and August 6, respectively, the survival of borers is not dependent on the maturity of the corn, or its date of silking.

From Table 2 it is seen that the percentages of survival for the May 7, 1927, plantings are consistently lower than those for May 2, 1927. The plantings on the different dates in 1927 were in different fields some distance apart and the causes for the differences in survival are not known.

A significant difference in per cent survival was found between the Red Cob Ensilage variety and all the other 5 varieties excepting Leaming, between Leaming and all the other 5 varieties excepting Ensilage, and between Golden Bantam and Northwestern Dent. The survival on the Golden Bantam variety for 1928 was 77 per cent greater than the survival on the field corn varieties, Leaming and Red Cob Ensilage, planted on the same dates.

No significant difference in per cent survival was found between Leaming and Red Cob Ensilage, between Flint, Northwestern Dent, and Red Evergreen, and between Flint, Golden Bantam, and Red Evergreen. A difference in survival between some varieties undoubtedly occurs, and an attempt will be made to obtain data to determine the extent and possible causes for the differences.

The Per Cent Survival

Based on a sample of nearly 25,000 eggs laid on all the corn varieties planted in 1928 on a 1.3-acre plot, the per cent survival averaged 35.6. An average of 3.73 borers were counted from 2,379 infested stalks.

Based on a sample of more than 26,000 eggs laid on all the corn varieties planted in 1927 on two plots, each one-tenth of an acre in size and some distance apart, the per cent survival averaged 34.0. An average of 7.78 borers were counted from 935 infested stalks.

The average per cent survival of 34.8 for 2 years is much higher than the 15 per cent commonly used for clean-up data purposes and gives a new appreciation of the reproductive powers of the insect.

Damage in Relation to Borer Population

Data comparing damage to the corn plant and different average borer populations are not available at this writing. An attempt was made in 1928 to obtain in 450-plant samples of one variety average borer populations from those causing slight loss to those causing complete loss. To determine the damage to the corn plant the individual stalk and ear from each sample will be weighed and compared with its borer population. The food constituents of the corn, and other data, will be obtained to compare with normal corn.

Artificial infestation of corn by use of egg clusters laid on waxed paper and then transferred to the heart of the plant was successful in 1928, and in 1929 an attempt will be made to ascertain the damage by different borer populations to a uniform strain of Clarage corn grown on three different soil types at three different levels of production.

Summary

Greater corn borer populations in the earliest plantings of both field and sweet corn are indicated as due to the preference of the corn borer moth for the tallest corn. Height of corn predominates as the factor in attracting the moths to oviposit except when the corn is of about average height or taller and such corn is near or in the silking stage and other plantings of corn are not. No significant differences were found in the percentage of corn borers reaching maturity on corn planted on different dates. In other words, the per cent survival of corn borers was not found dependent on the maturity of the corn, or on its planting date or date of tasseling or silking.

Greater corn borer populations in sweet corn and flint corn as compared to the larger field corn dent types are indicated as being partly due to a greater percentage of corn borers reaching maturity in the sweet and flint corn. The survival on the sweet corn variety Golden Bantam in 1928 was 77 per cent greater than that on the field corn dent types Leaming and Red Cob Ensilage. The corn borer moth shows no particular preference for sweet corn varieties upon which to lay eggs.

For all varieties of corn the per cent survival for the years 1927 and 1928 has averaged 34.8 per cent. This is much higher than the 15 per cent formerly obtained with artificial infestation and smaller samples and gives a new appreciation of the reproductive powers of the insect.

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PRESIDENT W. B. HERMS: The next paper is by H. L. Parker.

A STUDY OF THE ABUNDANCE OF *PYRAUSTA NUBILALIS* HUBN. IN CORN (*ZEA MAYS L.*) IN SOUTHWESTERN FRANCE

By H. L. PARKER, *Entomologist*, [1]W. R. THOMPSON, *Entomologist*, and P. DE RIPPAS and S. KOZLOVSKY, *Temporary Assistants, Bureau of Entomology*

This study was made in southwestern France during the winter of 1927–1928. The idea upon which it is based, namely, that of using the vegetation type as the most simple index to the numerous and complicated environmental factors, was proposed by E. N. Transeau[2] who says in regard to it "Enough is known * * * about the operation of ecological factors to warrant the use of an original vegetation type as an index of a definite complex of environmental conditions. Moreover it represents not only an evaluation of present soil and atmospheric factors but also of those of the past. It will probably be a long time before we can combine climatic and soil data and derive so satisfactory an index of the geographic distribution of particular biotic habitats."

Following this idea Mr. Transeau has studied the Mexican bean beetle in Ohio and the European corn borer. He finds the former abundant in the areas which are, or were originally, the Mixed Mesophytic Forests. In the case of the European corn borer he found that up to 1926 all the areas in which commercial damage occurred were "in areas

[1]Resigned June 1, 1928.

[2]Transeau, E. N. Vegetation types and Insect Devastations. Ecology, Vol. VIII, No. 3, July 1927.

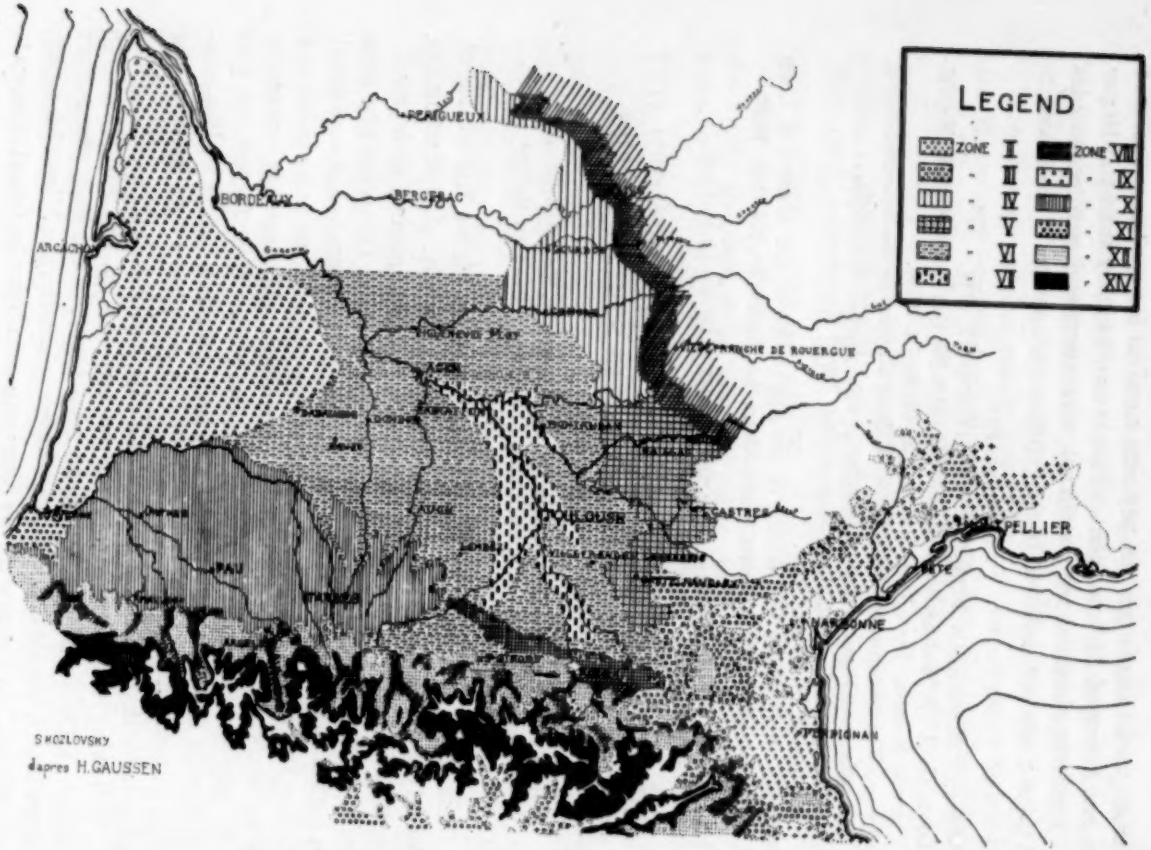

CHART I.—The Phytogeographic zones of South-Western France.

originally dominated by the series of associations from Phragmites Marsh to Swamp Forest" while infestation is much less in the Beech-Maple Forest areas and least in the areas formerly covered with Oak-Hickory.

The southwest of France, roughly speaking that portion south of a line drawn from Marseilles to Bordeaux (including, however, a central region extending north of Toulouse to include Cahors and Brive) and north of the Pyrenees has been studied by us. It is divided by its vegetal types into 3 regions comprising 15 zones.

They are indicated on Chart I[3] and are as follows:

1ST REGION

Zone I. Halophile; along the sea from the mouth of the Rhone to south of Perpignan and inward to Beaucaire; along the Atlantic coast from Bayonne to the mouth of the Gironde. This zone is unmarked on Chart I, as it does not enter into the discussion, being entirely halophile.

Zone II. Zone of the Olive. This zone extends inward from the sea over a belt of 30 to 40 miles with certain irregularities. The olive and *Quercus suber* characterize this as the Mediterranean zone.

Zone III. Zone of *Quercus ilex*. This zone is a narrow one slightly farther inland except in certain spots where it goes down almost to the sea in places, and extends from the region of Banyuls, around Carcassonne continuing north of Montpellier almost to Nimes. *Q. ilex* flourishes in this zone but the olive does not, though the olive zone (II) is a zone in which *Q. ilex* flourishes.

The foregoing three zones make up the Mediterranean region of this section of France.

2ND REGION

ZONE IV. Calcareous Zone, in which a penetration of Mediterranean plant combinations is highly accentuated.[4] This zone extends along what is known as the Petites Pyrenees from near St. Gaudens to near Axat passing between Foix and Pamiers and over an area north of Montauban, including Cahors Gourdon and extending north beyond Perigueux.

ZONE V. Non calcareous district, in which there is a highly accentuated penetration of Mediterranean combinations. This zone extends

[3]The authors are indebted to Mr. H. Gaussen of the University of Toulouse for his kindness in preparing for them the map upon which this chart is based.

[4]Characteristic plants of these penetrations are: *Spartium junceum, Quercus suber, Q. coccifera, Cistus salviaefolius, C. albidus, C. monspeliensis, Pinus pinea, P. halepensis, Juniperus oxycedrus, Calycotome spinosa, Erica arborea, Lavandula stoechas, Phillyrea angustifolia, Pistachia terebinthus, Rosmarinus officinalis, Thymus vulgaris.*

CHART I.—The Phytogeographic zones of South-Western France.

southward from Zone IV to a point below Castelnaudary. The Mediterranean penetration is similar to that in Zone IV excepting for some plants which even in the real Mediterranean zone live only on calcareous soils.

ZONE VI. Zone of *Quercus pubescens*. This zone occupies the central plain from Bergerac extending southeast to Pamiers and from near Mont-de-Marsan northeast nearly to Cahors and Gaillac. This zone is in general composed of compact soil very dry in summer and has extensive calcareous out croppings. There are semi-Mediterranean penetrations which advance towards Auch, Condom, Lectoure, near Toulouse and the Petites Pyrenees, but on the whole this zone can be characterized by the presence of *Quercus pubescens*.

ZONE VII. Zone of *Quercus sessiliflora*. This zone is irregularly crescent-shaped in outline, is surrounded almost entirely by Zone VI and covers Muret, Toulouse, and Montauban reaching almost to Agen, while one branch reaches down to Pamiers near Foix. It is a zone composed of gravel soils (or Boulbenes) which are more moist than in Zone VI. Semi-Mediterranean species are rare in this zone. It can be characterized by *Q. sessiliflora*.

ZONE VIII. Zone of *Quercus sessiliflora* and *Q. pedunculata*. This zone is composed of a narrow strip, situated northeast of Zones IV and V, extending in a northwest southeast direction along the foothills of the Massif central and various small lots extending up the lower valleys of the Pyrenees foothills. The soil is of a granitic nature and generally humid.[5]

These five zones, IV to VIII, constitute that part of the Aquitanian Domaine known as the Semi-Continental District, and is the region of France having the climate which more nearly approaches the true "Continental climate" than that of any other section.

ZONE IX. Zone of *Pinus pinaster* (*maritima*). This zone is situated along the Atlantic coast from Bayonne to the mouth of the Gironde extending inward almost to Nerac in the form of a triangle. It is a low flat country with a sandy soil covered by pines except for the cultivated clearings. It is the section known as the "Landes" and *P. pinaster* is very characteristic in this section. The climate is typically maritime.

ZONE X. Zone influenced by the Atlantic (maritime) climate. This zone takes in roughly Lombez, Mirande, St. Sever, Orthez, Pau, Tarbes,

[5]In the preparation of the chart by error a small area north of St. Girons and Foix was stippled by horizontal and *vertical* lines instead of horizontal and *diagonal*. This area is in reality a part of Zone VIII.

Mauleon, and Oloron reaching over to the Atlantic at Hendaye. It can be characterized by *Quercus tozza*, *Ulex nanus*, and *Lobelia ureus*.

ZONE XI. Zone of Ericacees. This zone is a small area around Bayonne and is characterized by a rather warm winter and the presence of a large number of Ericacees.

These last three zones (IX to XI) constitute the maritime portion of the Aquitainian Domaine (Zones IV to XI). In this Domaine it is worth while to note that in the maritime zones with the warm winter (climate of Biarritz, XI) a certain number of Mediterranean plants prosper which can tolerate the humidity but cannot endure the cold; a similar condition but less accentuated is found in Zones IX and X. The rest of the zones (IV, V, VI, and VII) of the Aquitainian Domaine is under the influence of a more rigorous climate, the winters are colder, and the summers are dryer and hotter (than in the maritime zones) which, even though the vegetation is that of occidental Europe, results in a predominance of "dry" types of this vegetation as well as demi-Mediterranean infiltrations. These plants can endure a rather cold winter provided that the summer be dry and hot. Zone VIII is slightly removed from the condition enumerated immediately above as it is influenced by the proximity of mountains and its humid soil, etc.

3RD OR MOUNTAINOUS REGION

Zone XII. Sub-mountainous stage. Humid. *Fagus silvatica* or *Abies pectinata* characterize this district.

ZONE XIII. Mountainous. *Pinus silvestris* (Not represented on chart).

ZONE XIV. Subalpine. *Pinus incinata.*

ZONE XV. Alpine. (Not represented on chart).

INFESTATION IN THE VARIOUS ZONES

No studies have been made in the western part of the French Mediterranean zone. For purposes of comparison however we may cite results obtained at Hyères[6] in the central part of the French Mediterranean zone during several years' previous work. In the Hyêres valley infestation generally does not exceed 40 per cent of the plants. In 1926 an examination of 10,600 plants gave 23 per cent infested, while in 1921 infestation was as high as 60 per cent. It must be remembered, however, that this is not a true index to the reproductive capacity of *Pyrausta nubilalis*, for corn is planted only in small plots, generally to shade violets, the fields are hand picked, and remaining stalks and stubble are

[6]Thompson, W. R., and Parker, H. L. Tech. Bul. 59, U. S. Dept. Agr., 1928.

pulled up and burned, so that a great majority of the borers are destroyed each year. Were it not for these cleansing operations the insects might be able to reproduce in vast numbers. It is worth while to remark, however, that practically no borers are found in vegetables, flowers, and wild plants. This fact is, in a way, an indication, for if the insect were stimulated by the Mediterranean environment to extensive reproduction it would certainly propagate in the above-mentioned plants.

The following Table (Table No. 1) will show the infestation as determined by us in the various zones.

TABLE NO. 1. INFESTATION BY PYRAUSTA NUBILALIS IN CORN IN THE VARIOUS PHYTOGEOGRAPHIC ZONES OF SOUTHWESTERN FRANCE

	Percentage of Infestation			Number of Stalks		
Zones	Minimum	Maximum	Average	Examined	Infested	Remarks
III....	7.33	40.33	17.21	1,900	327	
IV....	3.50	67.00	26.91	8,100	2,180	
V....	1.00	37.70	12.22	14,300	1,747	
VI....	0.66	52.00	18.15	22,200	4,030	
VII*...			25.00	150,000	37,500	
VIII....	0.75	25.50	11.93	5,600	668	
IX....	0.00	29.50	5.70	5,900	336	0 per cent in 8 fields
X....	0.00	35.33	8.84	15,100	1,335	0 per cent in 3 fields
XI....	0.00	10.00	2.35	4,600	108	0 per cent in 5 fields
XII....	0.00	30.35	9.87	5,200	513	0 per cent in 1 field
XIV.....	0.50	12.00	7.50	1,000	75	
All zones			13.5	83,900**	11,300**	

*No studies were made in this zone as in the other zones. The data inserted here are approximate, and are taken from a single locality, viz, St. Sixte, where a station for parasite collection has been operating for the last two years; these figures, for 1927–28, are inserted here for comparison and are not included in the totals.

**With exception of Zone VIII.

It will thus be seen that the heaviest infestation occurs in Zone IV and the lightest in Zone XI.

INFESTATION IN RELATION TO ALTITUDE

Altitude considered apart from other factors seems to have no real significance within certain limits. This species lives and flourishes at sea level as we have seen by a study of the Mediterranean region where infestation averages 23 per cent, but may go as high as 60 per cent; it flourishes on the plains of Central Europe at an altitude of 1,000 meters.

Evidently in the higher altitudes late plantings, high precipitations, and cold atmospheric conditions have an unfavorable influence on the abundance of the borer. In other cases where these factors are mitigated by the type of soil, as regards temperature, location, shelter, etc., the borer may be abundant.

The charts (2) and (3) representing Zones IV and XII are selected as the most striking examples. It will be seen that in the one case (Chart 2, Zone IV) the infestation diminishes as the altitude increases from 45.8

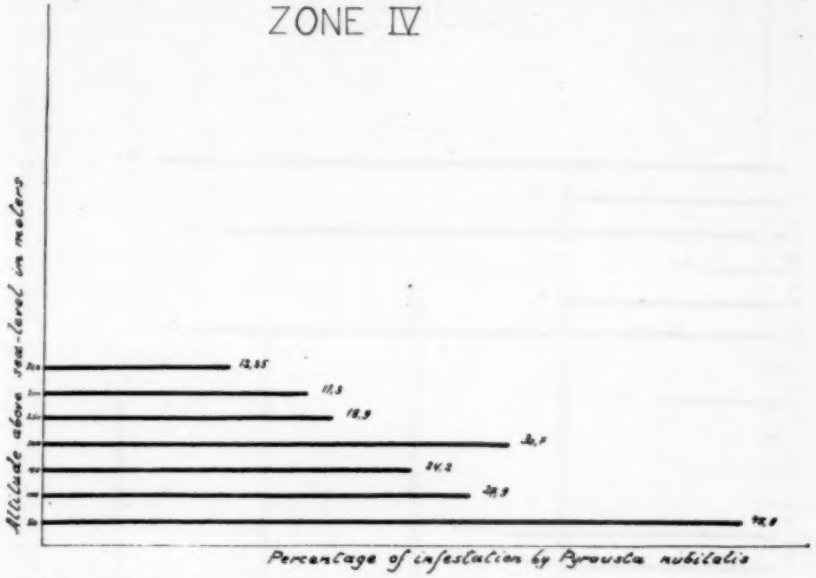

CHART 2.—Showing percentage of infestation in corn by *Pyrausta nubilalis* in relation to altitude.

per cent at 50 meters to 12.25 per cent at 350 meters. In the other case (Chart 3, Zone XII) the percentage of infestation increases as the altitude increases from 2.5 per cent at 150 meters to 30.3 per cent at 800 meters. The other zones examined give varying results to such an extent that if a chart is drawn for the data from all zones combined it will show an infestation more or less equal for all altitudes up to 800 meters.

INFESTATION IN RELATION TO SOIL TYPES

Independently of all other data we have examined in a very summary manner the infestation as related to different types of soil. The soils have been roughly classified[7] as sandy, clay, sandy clay, and calcareous

[7]This was done by Mr. de Rippas.

clay. It will be seen from the chart (Chart 4) that the infestation ranges from 10.6 per cent in sandy soils to 16.4 per cent in clay soils. These differences are so slight that their significance is extremely limited.

Infestation in Relation to Depth of Water Table

Since the floral characteristics are greatly influenced by the depth of the water table below the surface some observations have been made in

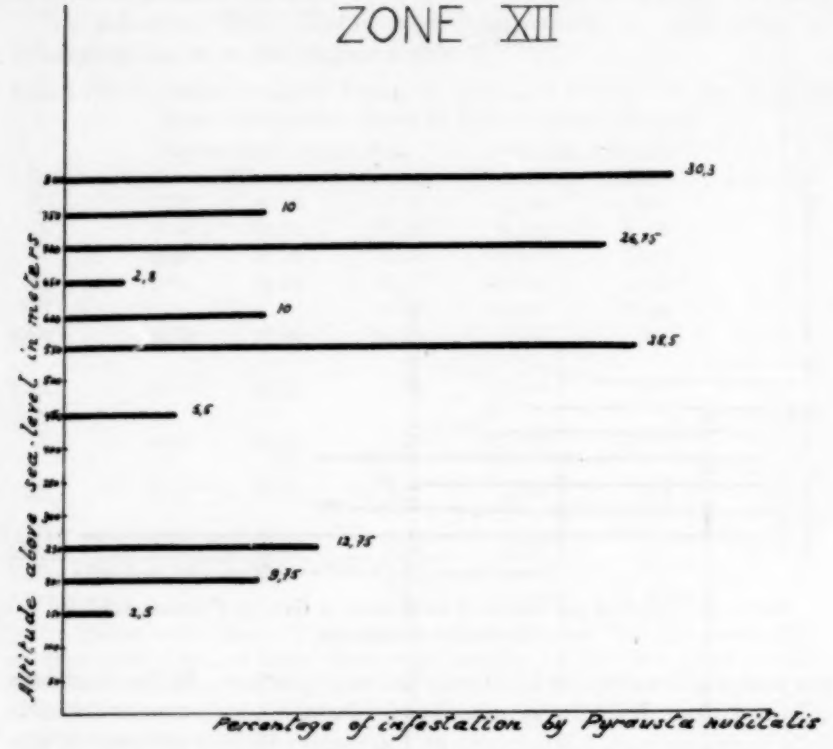

Chart 3.—Showing percentage of infestation in corn by *Pyrausta nubilalis* in relation to altitude.

relation to this subject. It will be seen by reference to the chart (Chart 5) that infestation within the limits of 1.2 per cent to 26.9 per cent has no definite relation to the depth of the water table. In Zone XII, for example, the average depth of the water table in the fields examined was 8 meters and the average infestation 9.87 per cent, while in Zone IV the water table is at 9 meters and the infestation at 26.91 per cent.

Infestation in Relation to Variety

An examination was made of infestation in relation to variety. The white variety of the Landes (Blanc des Landes) is found to be least infested over the whole area studied. The average infestation for this variety was 10.2 per cent, while the Landes Yellow (Jaune des Landes) is the most heavily infested, the average being 25.4 per cent. Other varieties and hybrids occupy intermediate positions, as will be seen by the chart (Chart 6).

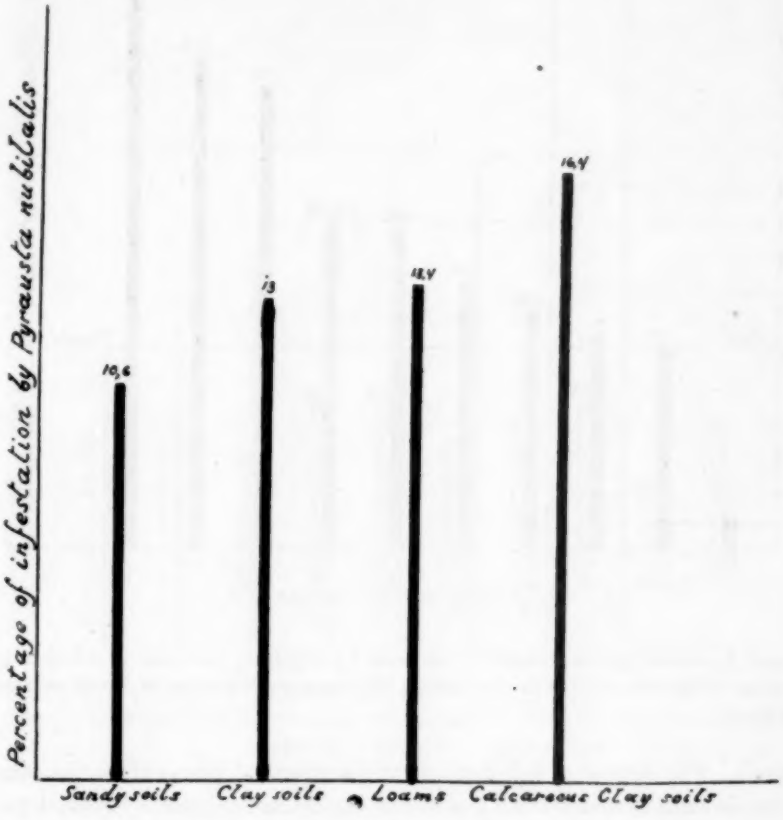

Chart 4.—Diagram of infestation in Corn by *Pyrausta nubilalis* in relation to soil types.

Summary

An extensive study of the degree of Infestation in Maize by *Pyrausta nubilalis* has been made in ten phytogeographic zones in southwestern

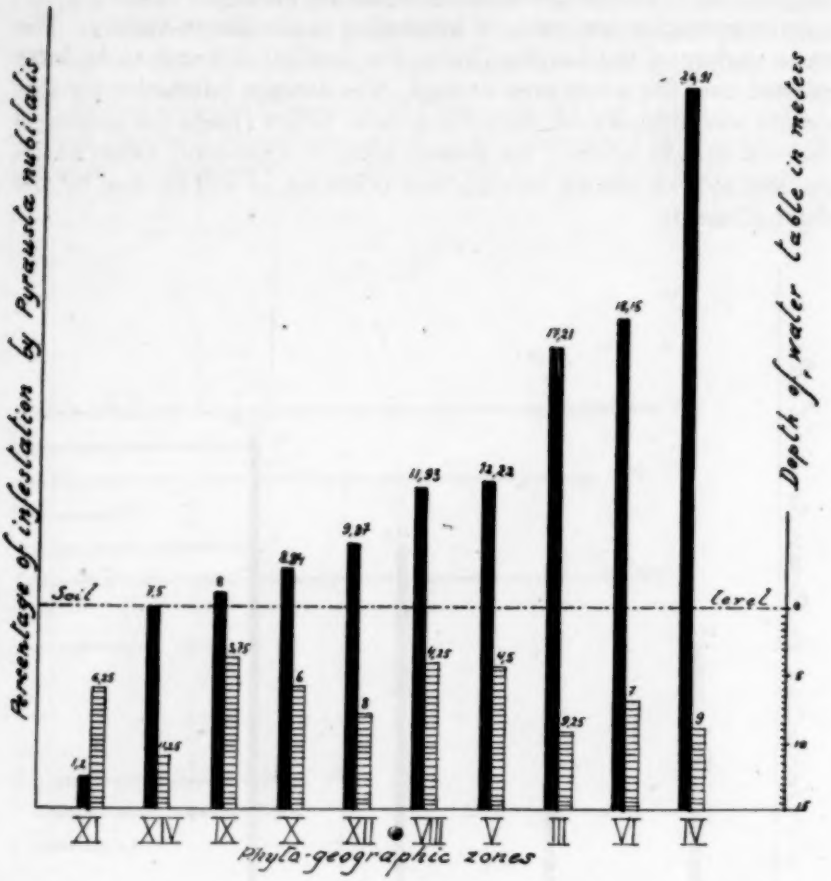

CHART 5.—Showing the infestation in corn by *Pyrausta nubilalis* in relation to depth of the water table in the various Phytogeographic zones of South-western France.

France. The degree of infestation ranges from 1.2 per cent in the zone of the Ericaceae under the influence of the Atlantic climate to 26.91 per cent in the zone characterized by calcareous soil and a pronounced penetration of Mediterranean flora. The authors are of the opinion that the various zones in southwestern France (as indicated in Table 1) with the possible exception of Zone IX (the low sandy pine-covered section known as the "Landes" section) do not differ enough in degree of infestation to permit these variations being ascribed to different

primary climatic influences as expressed by the dominant plant groups. In Zone IX, however, it is very likely that the climate is responsible for the constant low degree of infestation.

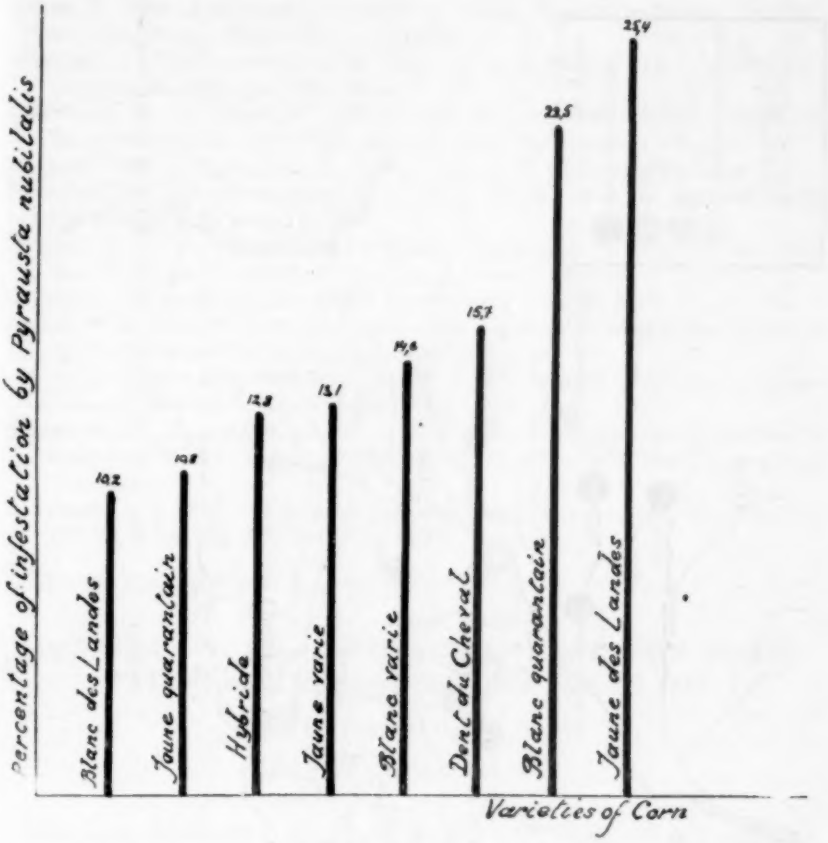

CHART 6.—Showing the percentage of infestation in corn by *Pyrausta nubilalis* in relation to different varieties

No definite relation exists between degree of infestation and altitude up to 800 meters, nor does there seem to be any definite relation between the depth of the water and degree of infestation.

Clay soils seem to be slightly more infested than sandy soils, running from 10.6 per cent in the latter to 16.4 per cent in the former over the entire area studied. It must be stated that our soil analysis was only approximative.

The low, sandy, pine-covered region known as the Landes (Zone IX) was found to be very slightly infested and this finding is further substantiated by several years' cursory examinations.

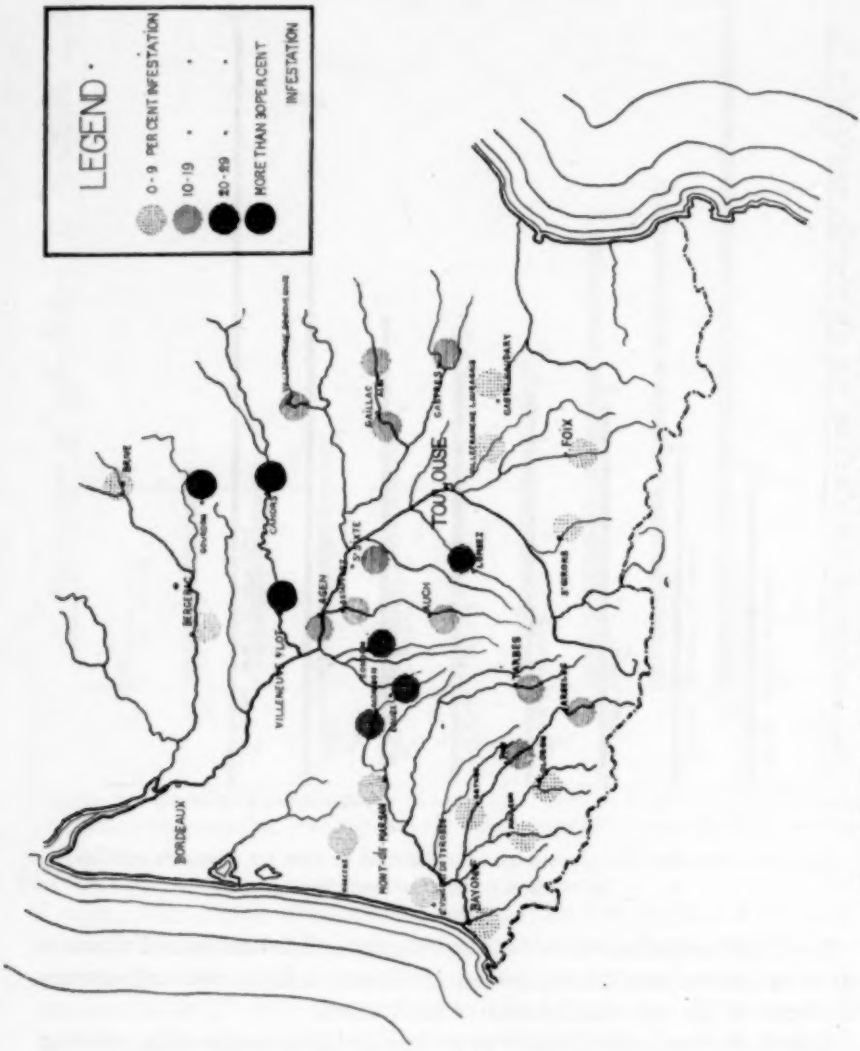

CHART 7.—Showing the geographical distribution of infestation in corn by *Pyrausta nubilalis* in South-western France.

Studies of infestation in relation to variety made over the entire region show that the lowest infested variety is the "Blanc des Landes"

(Landes White) which runs about 10 per cent and the highest is the "Jaune des Landes" (Landes Yellow) which runs about 25 per cent.

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This was followed by the next paper:

PYRAUSTA NUBILALIS IN EUROPE; NOTES ON INFESTATION AND PARASITES FROM 1926 TO 1928

By H. L. PARKER, *Hyeres, France*

(Held for publication later)

MR. C. L. MARLATT: We all realize, I think, that just now the corn borer fills a larger place in popular interest and creates a more widespread desire for accurate information as to outlook than any other pest of agriculture and this body here is the group of men who are studying the pest scientifically, the research men who are determining what this corn borer means to this nation, and to North America.

I have listened to the papers this morning with much interest and appreciation of the good work done and new ideas brought out. I appreciate also Mr. Houser's refusal to enter into the domain of prophecy, a very dangerous field to enter into. I want to keep away from that field myself, but in my official relationships I find it necessary to

...ing the geographical distribution of infestation in corn by *Pyrausta nubilalis* in South-western France.

defend very rapidly growing appropriations for this insect and the large special appropriations which have been made or suggested at various times. The question is put up to me and to others of us in Washington, "What is the corn borer doing? What does it mean now and what is the future?" That enters into prophecy.

We have discussed here these details of investigation and research. I suppose no body in the world is better able to interpret the history of the corn borer in this country than that assembled here.

It seems to me, therefore, that we could with profit spend a few minutes in discussion of this perhaps the most important subject that we have before us. I don't know that I am the person to do it. I can only give my reaction to the general information that has been gained during these years. The corn borer has had nearly 20 years of opportunity in this country, over large areas. What has it done in these areas and what is it doing now and what is the outlook? I have been very much interested in listening to the statements which were made, particularly by Mr. Caffrey in his very admirable review of the situation of the past season. As I recall it roughly, the damage this last season, 1928, in the United States, commercial damage, was practically negligible, limited to a comparatively few fields, to limited areas. Such damage in fact is practically limited as to excessive damage to a small area in Rhode Island, extending a little into Massachusetts where no clean-up measures have been undertaken and where the corn borer had had a free sweep.

In the western Great Lakes area, the intensive or at least fairly good clean-up on limited districts in certain states, Michigan, Pennsylvania, and New York, so affected the general average that there was scarcely any increase in the Great Lakes area.

I understand throughout the main bulk of that area away from the lake, i.e. away from the more intensely infested areas, the corn borer has maintained a slight increase. Put in percentages such increase may seem large, as for example 100 per cent, while in fact it may be merely an increase of two borers on a farm where one occurred the year before. At any rate throughout most of the area the rate of increase is such that commercial damage is still a very long ways off.

In the New York area about Schenectady there has been 19 years of opportunity and very few of the thousands of farmers concerned have experienced damage; in fact, most of them have scarcely seen the corn borer. On the other hand in the case of a good many farms, populations of 50 or more borers to the hundred plants, have been reached but even

there we are practically agreed that it takes 400 or 500 borers to 100 stalks to result in the beginning of commercial damage.

In New England, where we had formerly large commercial damage in the important truck regions about Boston, that damage has dwindled to a very minor character due to the natural fluctuations of the insect, but largely to the clean-up enforced by Massachusetts.

We have, therefore, this situation: The corn borer has been here 20 years. It has been over large areas for 20 years and this is the present record. I have here a statement which I saw quoted from Professor Caesar of the Canadian Government, along the same line. He said, "Two years ago 1200 square miles, were ruined or nearly so, in Canada. This year, 1928, not two dozen fields in the same area were anywhere near destroyed. Throughout Canada there has been great benefit in all districts by reason of clean-up." In other words, the corn borer there where it achieved its most striking damage, where corn was practically destroyed over a vast area has been well controlled by farm methods. So we have this picture that seems to me to be the correct one, namely, that so far the corn borer has not been a vast devastating thing to our corn crop.

The question of the future goes into prophecy. I have said in all my discussions of the corn borer, in all my representations to the Budget and to the Congress, that I believe in stating these facts which are encouraging as well as emphasizing the facts which show the worst side of the picture, as for example, this recent outbreak in Rhode Island, the tremendous losses in Ontario, the losses that accrued for a series of years around Boston and the losses along the lake border. In this way, I have endeavored to present the worst and the best, pointing out that no one can predict what will happen when the infestation by this borer spreads throughout the corn belt and elsewhere and has reached fair saturation and that no one can predict how long it will take to reach such saturation but at least such statement does indicate a hopeful phase as well as an alarming one. Such frank presentation of both sides of the picture, I have found has not interfered in one iota with getting adequate appropriations. I believe a frank statement goes better with the public, and with the important official public that we have to deal with, than any statement which may rest solely on the large elements of damage and ignored the more favorable or encouraging phases of the record.

In thus expressing my own point of view on this problem, I don't want anybody to get up and say I am fighting the men who are trying to

control the corn borer. I am willing to rest on my record of efforts to get corn borer control work adequately supported and carried out. I have defended all these appropriations before the committees, the big ones as well as the regular research appropriations, and I believe in them. I believe all the work that can be done in studying the corn borer scientifically should be done. I believe the natural control through parasites should be speeded up to the utmost. I am absolutely sold to all of that. I am sold to all the educational means that will get the farmers to do what they can to control the pest. Still I have a right to ask and the Budget and the Congress and others have the right to ask, what has the corn borer done? What is the record both bad and good? Namely, we should recognize the right of persons in interest to have information on which they can better appraise the problem and perhaps even draw their own conclusions.

MR. E. P. FELT: Wouldn't it be possible, following the suggestion of Dr. Marlatt, to take advantage of his request? Personally, I would like to see or hear brief reports in regard to the amount of damage done by the European corn borer in the various infested states, reports from men in those areas.

PRESIDENT W. B. HERMS: The next paper is by G. W. Herrick.

TWO SCALE INSECTS, THEIR BIONOMICS AND CONTROL

By GLENN W. HERRICK

ABSTRACT

The pine-leaf scale, *Chionaspis pinifoliae* Fitch, which infests various pines in private and park plantings and the magnolia soft scale, *Neolecanium cornuparvum* Thro., which infests magnolias are susceptible to the effects of certain contact insecticides, notably oils. There is a considerable interval of time when the young nymphs of the pine-leaf scale are unprotected by a waxy scale and when they can be hit with a covering spray while the nymphs of the magnolia scale are in a vulnerable condition from October to the middle of April. Satisfactory control of these two scales has been obtained by timely applications of oil emulsions.

For some years the writer has been giving special attention to a number of scale insects infesting trees and shrubs that serve as ornamentals on lawns of private homes, about the grounds of public buildings and in various parks of the State. At this time it is appropriate to report briefly on the results of the studies of two of these coccids, the pine-leaf scale, *Chionaspis pinifoliae* Fitch, and the magnolia soft scale, *Neolecanium cornuparvum*, Thro.

The Pine-Leaf Scale, *Chionaspis pinifoliae* Fitch

Scotch, Austrian, Mugho and White pines growing in parks or on lawns in the eastern United States, at least, are subject to infestation by the pine-leaf scale, *Chionaspis pinifoliae* Fitch. Often the infestation is severe, practically every leaf of Austrian and Mugho pines being covered with the female scales so that the trees appear distinctly whitened throughout. In the more serious instances the infested trees appear sickly, shed their leaves untimely and sometimes portions of them die. Many park superintendents and managers of estates have become greatly concerned regarding the scale and make anxious inquiries for methods of control.

Distribution, Hosts, and Injury. Apparently, the pine-leaf scale is a native insect and widely distributed in this country from the Atlantic to the Pacific coast and from the Gulf of Mexico north into southern Canada, at least. It has been reported from Maine, New York, New Jersey, Michigan, Illinois, Iowa, North Dakota, Colorado, Nevada, Idaho, Washington, Oregon, California, New Mexico, Missouri, Florida and Maryland. It is certainly widely distributed in New York State for our notes record its collection in the parks of Buffalo, Rochester, and Albany and from various other localities in the State including Ithaca.

During my observations of this insect in New York I have collected it from white pine (*P. strobus*), Austrian pine (*P. nigra* var. *austriaca*), Mugho pine (*P. mugo* and varieties), and the Norway spruce (*Picea abies*). It is recorded by different writers from a large number of forest pines and other conifers, a list too long for this brief paper.

One of the objections to this scale from park superintendents and private owners is that the evergreens when badly infested lose their characteristic color and become whitish in appearance. Of course the infestation also indicates a diseased condition which induces worry regarding the life of the valued plant. Moreover, the effect of the feeding of the multitudes of individuals is always weakening to the plant and often serious. The leaves become spotted with white areas which later turn reddish amd then darker while eventually the leaves become yellowish in color and die. The weakened tree thus becomes a prey to other pests, especially borers, and finally may succumb from the combined attacks of its enemies.

Life History of the Pine-Leaf Scale. A detailed account of the life cycle of this scale must be reserved for a future and more extended paper. From my investigations made during the season of 1927, I should have said that there was but one generation each year in central

New York. Observations made in 1914 by Dr. R. A. Matheson who has generously placed his notes at my disposal, tend to confirm the one generation. On the other hand Dr. L. P. Wehrle found a few females on some low-growing pines close to the south side of a building which were depositing eggs on July 11 of the past season. This indicates a second generation under favorable conditions. Certainly during the two seasons I have observed the scale on Austrian pines out in the open the majority of the eggs have hatched during late May and first half of June. In this situation on exposed pines the majority of individuals have not matured until the last of August and first of September and there has been no evidence that eggs laid by these hatch before the following spring. Some writers have said that there were two broods each season in Illinois and Massachusetts. Further observations will have to be made in order to straighten out some of these apparent contradictions.

CONTROL. Experiments extending through two seasons have shown that this insect can be effectively and economically controlled on pines and spruces, at least. Fortunately there is a long interval between the hatching of the eggs and the beginning of the formation of the scale by the young nymphs. In other words, the nymphs of the pine-leaf scale are bare and unprotected by a waxy scale for a considerable interval of time during late June and early July in the vicinity of Ithaca, at least. For example, in 1927 the eggs began hatching in perceptible numbers about June 20, but not a nymph began to form a definite scale before July 4 to 9. During much of this interval the nymphs were bare on the leaves and could be hit with contact mixtures.

On July 1, 1927, I sprayed a badly infested Austrian pine with Doane's solution, 1 gal. Volck oil, 7½ lbs. gold dust, ½ pint nicotine sulphate in 50 gallons of water. The results have been gratifying. Very few of the young nymphs which had settled ever lived to form scales and become adults. During the year the old white scales disappeared and since not over 3% of the young ones survived the application, the tree lost its whitish appearance and became clean and green again.

On July 4, 1928, I sprayed several Mugho pines and Austrian pines with a 1% dilution of Good's Keystone oil emulsion, with one pint of nicotine sulphate to 100 gallons. Unfortunately, the emulsion made with the chemically treated city water did not remain stable although it was perfectly satisfactory when first diluted in the tank. Nevertheless the pines were not burned and the control of the scale was as good as one could expect. Certainly 90% of them were destroyed.

In early July, 1928, Dr. L. P. Wehrle sprayed some small badly infested Mugho pines with Doane's solution. One of these low growing pines was white from the enormous number of scales that infested the leaves. Unfortunately for the definiteness of this work these pines were sprayed later with Doane's solution by a florist who was unaware of the first treatment. At any rate, the results were gratifying. The pines were nearly freed from their heavy infestation of scales. The upper sides of the leaves bore no living scales. Now and then a living female could be found on the undersides of the leaves which were probably not hit. It has been particularly gratifying to find that no injury to the pines has resulted from the use of the oils during the time of year indicated. From our experience during the seasons of 1927 and '28, I believe that the effectual control of the pine-leaf scale is a comparatively easy and economical matter.

THE MAGNOLIA SOFT SCALE, *Neolecanium cornuparvum* THRO

The magnolia (*Magnolia soulangiana*) is a very attractive plant for lawns, parks, and estates and is much used in ornamental plantings. Unfortunately it is subject to serious infestations of the magnolia soft scale, a pest which appears to be increasing in numbers and distribution.

A fine large specimen of this magnolia in Ithaca became coated from the ground upward with multitudes of the soft scale so that every branch bore thousands of the young hibernating nymphs. The previous summer the tree-shrub had suffered severely from the effects of the insects. Many of the blossoms had failed to develop and many branches had taken on a diseased appearance. Undoubtedly, the tree would have been killed in another season or two.

This scale occurs on various species of magnolia even on the deciduous *M. decuminata* of the northern states. It has been confused with *Lecanium magnoliarum* and has been discussed by some writers under that name. The scale has been reported from fifteen states east of the Mississippi River thus indicating a wide distribution in this country.[1]

Briefly the life history is as follows: the winter is passed by the young, dark-brown nymphs, each covered with a bluish waxy bloom. They may be present in enormous numbers on the branches of an infested tree, mostly on the undersides. The nymphs grow slowly and become mature in early August. By the middle of August the females are mature and the young are produced beneath the body of the mother insect, the latter being viviparous. The young nymphs remain under

[1]Dr. Harold Morrison very courteously furnished me with records of distribution from the files of the U. S. Bureau of Entomology.

the mother for a few hours and then settle along the branches. Each one molts once and thus passes the winter in the second instar. There is but one generation a year.

CONTROL. The overwintering nymphs are very susceptible to certain contact mixtures, particularly to oils. On April 18, 1928, I sprayed the infested magnolia with Volck oil at the rate of 1 part to 32 parts of water. The day was pleasant with the temperature above freezing while the following day, April 19, was also pleasant without rain and the temperature still above freezing until about 5 P.M. when it turned colder and on the morning of April 20, the temperature was 26°F. The oil had nearly 48 hours of favorable climatic conditions and apparently took full advantage of them. The magnolia was, of course, in a dormant condition although the buds had begun to swell. Particular attention was paid to insure the wetting of the undersides of the branches where most of the nymphs were situated.

Observations from time to time showed that the oil was very effective. The insect was nearly wiped out. On the underside of two or three branches, within a few inches of the ground, which were certainly not touched owing to their low position, the scales were as abundant as ever. These branches served as excellent checks. On the other parts of the tree there were three or four small groups of full-grown females near the tips of as many different branches. It is evident that the ends of these twigs were not covered with the oil. At this writing (December) the magnolia is practically free from the overwintering nymphs and no injury is apparent from the application of the oil.

MR. C. R. CLEVELAND: I would like to ask Dr. Herrick in what concentration the oil is effective.

MR. G. W. HERRICK: 1 per cent on evergreens, 3 per cent on magnolia in dormant condition.

MR. C. R. CLEVELAND: Is there any injury to evergreens at all?

MR. G. W. HERRICK: We didn't have any injury.

PRESIDENT W. B. HERMS: The next paper is by F. Z. Hartzell.

APPLICATION OF ONE OF PEARSON'S PROBABILITY THEOREMS AND SOME SPECIAL PROBABILITY EQUATIONS TO ENTOMOLOGICAL DATA

By F. Z. HARTZELL, *Associate in Research, N. Y. Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Entomological data that is dichotomously divisible can be analyzed by probability methods which seem preferable, in some cases at least, to the usual procedure. Pearson has furnished a system that is well adapted to such an analysis. The

method of determining the probable error of a percentage is included for use with certain data.

Illustration of a Common Method of Biometrical Analysis

In Table 1 are given data taken on two comparable plats at Geneva.

Consider first the aim of the analysis. It is desired to learn whether or not in this test the number of apples injured by codling moth in the sprayed plat is significantly different from the number of apples injured by the same insect in the dusted plat. A usual method of analysis is to make calculations using the percentage of injury per tree as the unit. The table gives the "statistics" based on this unit. The term "statistics" when used with quotation marks will be used in the sense defined by R. A. Fisher (3).[1] It should be noted that the standard deviations were calculated from the formula $\sigma = \sqrt{\frac{\Sigma_d{}^2}{n-1}}$ where d is the deviation of an observation from its mean and n is the number of observations. Then each σ was corrected for the small number of observations by a method discovered by Pearson (8). The correlation coefficient, corrected for small numbers by a method of Soper, Young, Cave and Pearson (11), was used in determining the probable error of the difference between the two means. The odds are about 12 to 1 that the difference is not due to fluctuations of random sampling. Generally odds of 30 to 1 are desired. Therefore, the difference 3.29 ± 1.24 per cent cannot be considered as without the pale of sampling fluctuations *if the percentage of injury per tree is made the unit.* Should this be the unit?

The variability of the trees as regards infestation is not so much the object of the investigation as is the variability of the infestation of the apples, of which 25,331 (150 bushels) were examined. The calculated percentages take no account of the actual yield, but only of the relative numbers of total and injured fruits. Furthermore, if a keen fruitgrower had examined these same apples there would be no question in his mind which plat gave the better practical result. In other words, the analysis just given satisfies neither the biometrician nor the practical man, at least so far as the question of the amount of injury to the fruit is concerned.

Application of Particular Probability Concepts and Mathematics

In the analysis just given the logic and formulae belong to that class of the statistical series designated by Charlier, according to Arne

[1]The numbers in parenthesis following a name refer to citations of literature given at the end of this paper.

TABLE 1. CODLING MOTH INJURY ON TWO PLATS WITH DIFFERENT TREATMENT

Sprayed Plat — Lime-Sulfur and Arsenate of Lead				Dusted Plat — 90–10 Sulfur Arsenate of Lead Dust			
Tree Number	Total Number Apples	Number Apples Showing Codling-Moth Injury	Percentage Apples Injured	Tree Number	Total Number Apples	Number Apples Showing Codling-Moth Injury	Percentage Apples Injured
1	1,804	102	5.65	1	1,083	118	10.90
2	1,811	88	4.86	2	1,011	48	4.75
3	860	2	0.23	3	946	128	13.53
4	1,671	7	0.42	4	840	37	4.41
5	1,078	11	1.02	5	2,347	41	1.75
6	1,204	9	0.75	6	2,404	69	2.87
7	1,199	17	1.42	7	2,548	38	1.49
8	2,149	13	0.61	8	2,376	38	1.60
	11,776	249	8/14.96		13,555	517	8/41.30
			1.87				5.16

Standard deviation (σ_1) =2.46
Mean percentage injury per tree 1.87±.59
Difference per tree 3.29±1.24
Ratio of probable error to difference 2.65
Odds about 12 to 1

Standard deviation (σ_2) =5.29
Mean percentage injury per tree 5.16±1.26

Correlation coefficient between injury per tree in the two plats r =+.26

Fisher (2), as the *heterograde series* or as Yule (12) divides the subject, "The Theory of Variables." Suppose the apple is made the unit and an analysis be made according to the mathematics of the homograde series of Charlier, the "Theory of Attributes" of Yule.

The total number of apples in each plat is considered as a population (n). This population, by dichotomy, can be divided into the number of "injured" apples (p) and the number "not injured," i.e., "clean" (q). Obviously $p+q=n$. Now according to the theory of probability, if an event can happen in p ways and fail in q ways, where $p+q=n$, the total number of events, then $\frac{p}{n}$ is the probability of the event happening and $\frac{q}{n}$ is the probability of the event failing. Let $\frac{p}{n}=\bar{p}$ and $\frac{q}{n}=\bar{q}$. Then $\bar{p}+\bar{q}=1$. Thus it will be seen that the data of the population of apples is very similar to that secured from games of chance and therefore logically can be studied by the mathematics of the homograde series.

Since the populations are not the same a simple comparison can be made by computing for the dusted population *the expected number* of apples injured by codling moth on the assumption that the apples had been sprayed instead of being dusted and that the proportion of injured fruit would remain the same as on the plat actually sprayed—an assumption that is always made in test plat comparisons. Call this the *expected mean* and calculate its probable error as explained below. The *observed mean* is the number of injured[2] apples counted. Calculate the probable error of the observed mean and make the comparisons.[3] The following equations from probability mathematics of the homograde series are needed:

$$\text{Expected mean} = n_2\bar{p}_1 \quad \ldots\ldots (1),$$

$$\text{Probable error of the expected mean} = .6745\sqrt{n_2\bar{p}_1\bar{q}_1} \quad \ldots\ldots (2), \text{ and}$$

$$\text{Probable error of the observed mean} = .6745\sqrt{n_2\bar{p}_2\bar{q}_2} \quad \ldots\ldots (3)$$

when the constants have the meaning that follows:

[2]The terms *injured* and *infested* are used interchangeably.

[3]The method is not recommended because it is not as accurate as that of Pearson given below. It is given, however, to acquaint the reader with the methods of elementary probability as well as to serve as a comparison with Pearson's method. Then, too, the method has been recommended in the past and if not mentioned here the beginner may happen upon it and decide to use it because of its simplicity. Thus he might be led into drawing conclusions that are not warranted by the data unless the discrepancies between the two methods are shown.

	Sprayed Plat	Dusted Plat
Total population of apples	$n_1 = 11776$	$n_2 = 13555$
Number of infested apples (= observed mean)	$p_1 = 249$	$p_2 = 517$
Number of clean apples	$q_1 = 11527$	$q_2 = 13038$
Probability that an apple will be infested	$\bar{p}_1 = \frac{p_1}{n_1} = .021145$	$\bar{p}_2 = \frac{p_2}{n_2} = .038141$
Probability that an apple will be clean	$\bar{q}_1 = \frac{q_1}{n_1} .978855$	$\bar{q}_2 = \frac{q_2}{n_2} .961859$

Substituting the values of the constants in equations 1, 2 and 3 there result:

Observed mean = 517.00 ± 15.51

Expected mean = 286.62 ± 11.30

Difference = 230.38 ± 19.19

Ratio of difference to its probable error 12.01:1.

This ratio is beyond the ordinary probability table calculated from the normal curve of error such as given by Pearson (9), Davenport (1), Glover (4), Kelley (5), and others. Pearl (6) gives, for a ratio of 10:1, odds 65,000,000,000 to 1 which shows the present odds to be overwhelmingly large, so the difference is not due to the errors of random sampling.[4]

Pearson's Theorem of Past Experience and Future Expectation

Pearson (7) has shown that the method just given is not very accurate, especially in computing the probable error of the expected mean. He developed, in 1907, a theorem entitled "On the Influence of Past Experience on Future Expectation." This important contribution seems to have escaped the notice of American workers until brought to light by Pearl (6).

Using the notation given above, the equations are:

$$\text{Expected mean} = n_2\bar{p}_1 + \frac{n_2}{n_1+2}(\bar{q}_1 - \bar{p}_1) \quad \ldots\ldots (4)$$

$$\text{Expected } \sigma = \left\{ n_2 \left(\bar{p}_1 + \frac{\bar{q}_1 - \bar{p}_1}{n_1+2}\right)\left(\bar{q}_1 - \frac{\bar{q}_1 - \bar{p}_1}{n_1+2}\right)\left(1 + \frac{n_2+1}{n_1+3}\right) \right\}^{\frac{1}{2}} \quad \ldots\ldots (5)$$

$$\text{Probable error of the expected mean} = \pm .67449\,\sigma \quad \ldots\ldots (6)$$

Pearson states if "the characteristic does not occur in a disproportionately large or small section of the population" (i.e., if $\bar{p}$ is neither

[4] Of course this assumes that equal care was exercised in the examination of every apple in the two plats and that personal errors of judgment were proportionate to the number of injured apples in both plats.

extremely large or small) "then, if the samples are considerable as they mostly will be in safe practice, $(\bar{q}-\bar{p}) / (n+2)$ may be neglected and" (our equation 5) "gives:[5]

$$\sigma^2 = n_2 \bar{p}_1 \bar{q}_1 \left(1+\frac{n_2}{n_1}\right)" \ldots\ldots (7).$$

"Hence a first sample n_1, having given a percentage value of the characteristic p_1 a second sample of n_2 individuals may be expected to give:

$$100\ \bar{p}_1 \pm 67.449 \sqrt{\bar{q}_1 \bar{p}_1 \left(\frac{I}{n_2}+\frac{I}{n_1}\right)}" \ldots\ldots (8).$$

Substituting the values given above in equations 3, 4, 5 and 6 gives for comparison:

Observed mean = 517.00 ± 15.04
Expected mean = 287.72 ± 16.57
Difference 229.28 ± 22.38
Ratio of difference to its P. E. 10.244:1.
Odds greater than 65.000,000,000 to 1.

It will be noted that, in this example, the differences between the expected means calculated from equations 1 and 4 are not marked, but that the probable error of the mean by Pearson's equations (our equations 5 and 6) is almost 47 per cent higher than that calculated by the simple probability equation (equation 2) which in turn causes the probable error of the difference to be 16.6 per cent greater by the Pearson method. Thus, by the ordinary formula the confidence given by the ratio of the difference to the probable error is more than is warranted by the facts. While this is not important in the example given it might allow erroneous conclusions to be drawn when the ratio by Pearson's formulae would be around 3:1.

The Probable Error of a Percentage

Since the probable error of a probability, or, as it is called by Rietz (10), the "probable error of relative frequency," is given by the equation

$$\text{P. E } \bar{p} = .67449 \sqrt{\frac{\bar{p}\,\bar{q}}{n}} \ldots\ldots (9),$$

the equation for the probable error of a percentage is easily derived by multiplying each member by 100:

$$100 \text{ P.E. } \bar{p} = 67.449 \sqrt{\frac{\bar{p}\,\bar{q}}{n}} \ldots\ldots (10)$$

At the Geneva Station a vast amount of work has been done on San Jose scale and, as long as the problem of the probable error was con-

[5]The notation of the present paper is substituted in this quotation to avoid confusion.

sidered under the mathematics of the heterograde series, no advance was made in calculating a true probable error, various make-shifts being used. Using equation 10, which belongs to the mathematics of the homograde series, the problem is exceedingly simple. Let n = number of scale examined, p = the number of dead scale and q = the number of scale living. Then $100\ \bar{p} = 100\ \frac{p}{n}$ = percentage of scales dead. The equation for the calculation of the percentage dead together with the probable error then would be

$$\text{Per cent dead} = 100\ \bar{p} \pm 67.449\ \sqrt{\frac{\bar{p}\,\bar{q}}{n}} \qquad (11)$$

Suppose 500 scale insects were examined and 104 were found to be dead, then $p = 104$, $q = 396$, $n = 500$, $\bar{p} = \frac{p}{n} = \frac{104}{500} = .2080$ and $\bar{q} = \frac{q}{n} = .7920$. Substituting the above values in equation 11 the percentage of scale dead would be 20.80 ± 1.22.

It may be desirable in an investigation to know the number of insects necessary to examine to reduce the probable error of a percentage to a certain amount. Let ϵ represent the magnitude of the probable error in per cent. Then equation 10 would become:

$$\epsilon = 67.449\sqrt{\frac{\bar{p}\,\bar{q}}{n}}, \text{ and,}$$

solving for n, becomes $n = (67.449)^2\ \frac{\bar{p}\,\bar{q}}{\epsilon^2} \qquad (12)$

Assuming that the same ratio will be found in a larger sample, suppose that it is desired to reduce the probable error of the percentage of scale dead to 0.5 in the example given previously where $\bar{p} = .2080$ $\bar{q} = .7920$, and $\epsilon = 0.5$. Substituting these values in equation 12, $n = 2998$. Thus it would be necessary to examine about 3000 scale to reduce the probable error in the percentage to approximately 0.5. If two plats are to be compared, then it would be necessary to use equation 8 to compute the expected percentage.

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PRESIDENT W. B. HERMS: The next paper is by Herbert Osborn.

LEAF-HOPPER IMMIGRANTS OF ECONOMIC INTEREST

By HERBERT OSBORN

ABSTRACT

The leafhoppers of this country have not been given due consideration owing to their small size and inconspicuous character. The restriction to introduced plants and the absence of seasonal cycles are suggestive of immigrants from tropical regions. The egg stage is favorable to the introduction of such species. Observations are given on the introduction and distribution of the following: *Idiocerus scurre, I. cognatus, Allygus mixtus, Platymetopius hyalinus, Deltocephalus pulicarius, D. pascuellus, D. ocellaris, D. collinus, D. flavicosta, Euscelis obscurinervis, Draeculacephale reticulata, Cicadula 6-notata, Balclutha punctata, Empoasca fabae, Eutteryx melissae, Tryphlocyba ulmi, T. rosae, Perkinsiella saccharicida and Peregrinus maidis.*

Among numerous introduced insects that have become of economic importance in this country, the leafhoppers, while having received less attention than some other groups, should be recognized as worthy of consideration. The fact that they have received less attention is in part due to the minute size and inconspicuous character and in some cases doubtless on account of the injuries being attributed to other causes.

It may also be noted that many of the species may have been considered as native to the country since their introduction and distribution has been so obscure and unheralded that they have not received popular notice. It may be noted also that with the increase and rapidity of transit in commerce, especially from tropical countries that we may expect many additions and probably some of them, at least, of large economic importance. If we consider the immense amount of the im-

portation of fresh fruits and vegetables from the tropical or subtropical regions we can appreciate the abundant opportunity offered to such insects for transportation and possible establishment within our borders. Also the introduction of tropical or subtropical plants for cultivation in the southern states or in greenhouses gives very favorable opportunity for the transportation of these insects and moreover the very inconspicuous character of the eggs makes it particularly difficult to detect their presence even with a thorough inspection at ports of entry. We have also to consider the possible introductions by gradual dispersion over land connections as well as by wind, oceanic currents or other means of natural distribution.

In general it may be considered that such introductions with final establishment may be limited to such plants as are related to the native hosts of the species.

Certain factors may be considered in determining whether a species has been introduced from a tropical region as for instance the restriction to introduced plants and without occurrence on plants considered native. Another point to be considered is the adaptation of the life history and habits to a seasonal cycle as the tropical species do not have the same adjustment to seasons as those forms which have been indigenous in temperate regions and are thoroughly adapted to the life cycle of the plant as well as to the climatic conditions.

As to modes of transportation the leafhoppers seem most likely to be carried in the egg stage and this method must be particularly favorable for those forms which have an extended egg period so that there is sufficient time for the transportation of the host plant or parts of the plant in which they may be deposited. This method is apparently most available for importation from Europe or northern Asia. Introduction in nymphal stages would appear to be dependent upon rapid transit and connection with food supply with opportunity to transfer to living plants upon arrival. Somewhat the same condition might apply to adults, although, for hibernating species, it would seem possible for introductions to occur by means of a connection with objects in which the insects might be secreted. These different modes of entrance are of course fundamental to possible methods of exclusion.

A short review of some of the species supposed to be introduced will illustrate the importance and varied problems connected with the group. Among the Cicadellidae we have very clear cases of recent introduction from Europe. For *Idiocerus scurra* which was first noted in this country in 1914 it is not known where this species was introduced but it was first

reported from New York and has been noted as far west as Ohio. *Idiocerus cognatus* reported in 1917 is a serious pest on poplars and is likely to spread through the eastern and mid-western states.

Allygus mixtus has been found at Boston in the Arnold arboretum and it would seem quite probable that it was introduced with European trees. Likewise *Platymetopius hyalinus* first noted on Japanese maples in Washington has been found as far south as North Carolina, west in Ohio and east in New England. This may have been brought from Japan with imported maples.

In the genus *Deltocephalus* there are a number of species common to Europe and America and it would be rash to assert recent introduction for any of them although *pulicarius*, first recorded from Maine in 1913, might be considered as a possible case. *Pascuellus*, *ocellaris*, *collinus*, *abdominalis* and *striatus*, which are common to both Europe and North America, from their distribution and the fact that they have been known in both regions for a long period seem more likely to have had their distribution in a remote period. The grass infesting habits of these species make their transfer much less probable than for species which deposit eggs in the bark of woody plants. *D. flavicosta*, common in subtropical and tropical America has probably reached its wide distribution mainly or entirely by land dispersal.

From the south one of the most important species is *Euscelis obscurinervis* which has every evidence of being a tropical species since it occurs throughout a very wide range in South and Central America and the West Indies and was first recorded for the United States under the name of *exitiosa* from South Carolina. This species now occurs throughout a large part of the United States and is an important pest. Another species, *Draeculacephala reticulata*, described from Cuba was recognized in Texas and Florida and now in Tennessee and Kentucky with occasional reports of serious damage to cereal crops.

Cicadula 6-notata offers a somewhat puzzling case as it appears to have been overlooked by Say, and most other early American entomologists, but to have become very abundant and conspicuous in the latter part of the 19th century. Its common occurrence on oats would make possible its transportation in straw and we might conceive an introduction something over a century ago as the first known specimens appear in the Harris collection with dates of 1833 but we really have no basis for definite conclusion. Our American forms seem to present the same variations noted in Europe and if the species had holarctic distribution in preglacial time it must have maintained its specific features with

great fidelity. Almost the same statement might be made of *Balclutha punctatus* but the species has much less of economic importance.

The very common *Empoasca fabae* while known for nearly a century is very probably tropical in origin since its list of host plants and the life cycle seem to be especially adapted for tropical conditions.

Of other Typhlocybine forms such species as *Eupteryx melissae* occurring on mints may easily have been brought in living plants while *Typhlocyba ulmi* and *rosae* would seem more likely to have come in twigs or buds of imported elms and roses. *Erythroneura*, more evidently an American genus, has few species in common and is probably less easily transported, although hibernating forms might be carried in moss, leaves or packing material.

Among the Delphacidae there are a number of species that have proven of major importance when transferred from their native habitats. Perhaps the most notable case is the sugar cane leafhopper, *Perkinsiella saccharicida*, which at one time was a most serious threat to the sugar industry of the Hawaiian Islands but fortunately controlled by the introduction of parasites. The species has, fortunately, not been imported to the southern states or the West Indies but should be given close attention to avoid any possibility of its introduction.

Another species abundant in the southern states and in all probability an introduced species is the corn leaf hopper, *Peregrinus maidis*, first described from Florida by Ashmead but since reported from such widely scattered regions as Hawaii, Ceylon, West Indies and South Africa. Where its original home and food plant may have been is a question but it certainly thrives on corn and related plants of the grass family, and may have been distributed as eggs or adults in living plants or packing material.

There are many other species which have quite certainly come in to the United States from countries to the south and there are doubtless many species which, if opportunity offers, may become very serious pests within our boundaries. It is therefore important that exploration of the tropics be continued with special reference to forms which might be a menace to our crops and it would even seem fully warranted to establish observation stations in some of the tropical countries, particularly in the Canal Zone, in order to determine possible pests and to learn everything possible concerning their biology, possible means of transportation, range of food plants and natural enemies.

In brief we may say that we have already received a number of important leaf hopper pests as immigrants from the old world and tropical

America, that there are many other species that are potential pests if introduced, and that it would seem to be the part of wisdom to learn everything possible regarding such species in order to perfect methods of inspection, quarantine, and control.

PRESIDENT W. B. HERMS: The next paper is by C. I. Bliss and A. W. Cressman.

EFFECTS OF OIL CONCENTRATION AND POPULATION DENSITY ON CAMPHOR SCALE (*PSEUDAONIDIA DUPLEX*) CONTROL WITH OIL EMULSIONS

By C. I. BLISS and A. W. CRESSMAN, *New Orleans, La.*

(Withdrawn for publication elsewhere)

[Owing to the large proportion of papers not in the hands of the Editor, the proceedings will be continued from this point in the April issue. E. P. F.]

WHAT SHALL WE TEACH STUDENTS IN BEGINNING ENTOMOLOGY?

By PAUL KNIGHT, *Instructor in Entomology, University of Maryland*

ABSTRACT

The selection of the aims or objectives of the elementary course are discussed in the light of the opinions of dozens of teachers throughout the United States and Canada. The question as to the approach of the first course, whether it shall be economic or fundamental is taken up more particularly. A tabular analysis of twelve elementary courses at different institutions, furnished by the instructor in charge, is presented at the end of the paper.

The objectives of an elementary course probably concern a teacher more than any single problem. Upon the selection of these aims depends in a large measure the effectiveness of the course. A recent survey by the author, (unpublished), shows much interest on the part of teachers in this problem. The entire situation resolves itself into one question; What shall we teach students in the beginning course in entomology?

From a large mass of recent correspondence on hand the greatest diversity of opinion is evident. Some is presented in this paper. The difference of ideas is so great that no definite recommendations could possibly be made, but some of it will perhaps be of interest to instructors in charge of the elementary course. This situation is quite natural, as the way teachers were trained, their particular line of interest, and the demands of the institution will all have their influence.

The replies received show teachers quite sharply divided on the question of teaching a strictly fundamental or an applied first course. The chief reason most teachers gave for insisting on a strictly scientific beginning course was the question of prerequisites to the advanced

courses; that the students must have a fundamental knowledge of insects before they can proceed to the practical applications. From the standpoint of the subject matter of insect study this is no doubt the logical view, though other factors enter in. One entomologist, though not a teacher, takes a rabid view;

Judging from your questionnaire, entomology is not considered a branch of biology which deals with insects, but rather as a separate subject of only remote biological interest . . . The first course in entomology, (which is always a second course in their biological training, I believe,) is none too early to start teaching them to be first scientists, secondly biologists, and last of all entomologists. A good course in experimental psychology would probably be better training for an entomologist than the usual treatment of the elementary, and also the advanced courses in entomology.

Most teachers take a rational attitude on the problem of what the objectives should be;

An informational course useful for direct application has a very definite and important place in a trade school. It has no place as a college subject claiming equality with fundamental courses.

We receive in this school the general students, who are going into a wide range of professions. . . . Consequently we have not stressed the economic aspects of entomology, but aim to give a birds-eye view of the several interests of the subject. We have stressed the question of insect behavior because we believe there is considerable appeal to the person, who will never engage in entomology professionally, in the ways of the insect world.

Our first course is largely systematic, biologic, and morphologic.

We teach entomology, not crop pests, leaving this for later courses.

I think a technical course always should be given in preparation for an economic one.

One possible discrepancy in this attitude is that a knowledge of insects and their relation to man might be considered a fundamental part of the subject, though this is not the usual conception.

The teachers holding that the elementary course should be of a practical or direct nature are equally emphatic in their opinions, and this group is strongest in numbers. Their attitude hinges on one important teaching device, student interest. This group insists that the students must be impressed with the importance and magnitude of the subject, and must have their minds properly prepared and their interest aroused before they can do their best work. These men admit that the arrangement is not scientifically logical, but think it psychologically desirable to approach a first course in this way. The main function of such elementary courses is to give a strong introduction to insects, to create an everlasting impression, and then lay the foundation for future work.

Why not interest the entire group at the outset before plunging headlong into technicalities which mean nothing until the interest has been aroused? Such a plan, of course, is hardly necessary for the student who is determined at the outset to major in entomology, but these numbers are the smallest with which the average teacher deals. Following are extracts of particular interest to this school of teachers;

I believe that the type of elementary entomology course given in many institutions, dealing with the classification in the lectures and anatomy in the laboratory, without opportunity for much field work, defeats the purpose of the course. It makes drudgery out of what could be made a pleasure to the students.

I think that the first difficulty to overcome is to show the students how they are affected by the insect world, and the general importance of insects, so that they may feel the study is worth while.

I believe in a first course having strong bearing on the relation of insects to man, the monetary losses caused by insects, and the organizations working to advance the science of entomology. Students should be made early to realize that insects are the most serious competitor of man.

In our elementary course we try to impress students with the vital importance of insects to man, and particularly to agriculture.

I feel that in this course, I could characterize it by saying it is a publicity course in scientific economic entomology. It is necessary first, to secure the proper mental attitude from the student, and second, to teach him scientific facts after his mind is sufficiently prepared.

I should say the objectives might be as follows:

1. To secure a real and lasting interest in entomology on the part of the student.
2. To show the relation and importance of entomology to agriculture and human welfare.
3. To give the fundamentals of insect life, (a) to the student who takes no more entomology, and (b) to the student who takes later courses in economic entomology.

The course in elementary entomology at ———— college, which is an agricultural college has for its aim:

1. To introduce students to insect life in general, in such a way as to be not only cultural but informational in character;
2. To awaken interest in insect life; and
3. To become acquainted with the chief economic forms and the part they play in agriculture.

There were enthusiastic entomologists before there were courses in entomology. Being made to make a series of careful drawings and to label all the parts of some ill smelling alcoholic specimen would have effectually snuffed out the awakening enthusiasm of Thomas Say.

Professor J. J. Davis shows that of the agricultural men at Purdue University, (his largest group) 36 per cent return to the farm, 36 per

cent take up some form of educational work, 14 per cent accept commercial positions of agricultural nature, the remainder being unknown. Professor Kinsey of Indiana University is teaching a course largely from the angle of what he calls "dynamic biology." His students on leaving the university go into a wide variety of work. For this reason he stresses behavior, interrelations, and other aspects of the subject which have considerable appeal to everyone.

The geographical location of the school often determines what shall be taught, or at least how it shall be taught. Professor Stafford of

Divisions of Course	Connecticut Agr'l College	University of Idaho	University of Illinois	Indiana University	University of Maryland	Mississippi A. & M. College	University of Michigan	University of Missouri	University of Nebraska	Ohio State University	Smith College	University of Tennessee	Extremes of Variation
Importance of Insects.....	3%	5%	3%	10%	20%		1%	2%	1%	6%	5%	1%	1–20%
Biological Position....	1½	5	2		10	5	25	2	4	1	5	1	1–25%
Anatomy of Insects.....	19	15	15	11	15	20	20	8	35	9	30	15	8–35%
Development, Metamorphosis	5	5	5	2	10	5	4	2	2	2	5	5	2–10%
Insect Physiology**..		*							4				0–4%
Insect Ecology**		*		12	*								0–12%
Insect Behavior**..		*	*	40	*				1				1–40%
Classification of Insects...	11	20	5	10	10	35	30	12	20	2	30	5	1–40%
Control of Insects.....	3	10	15	5	15		3	18	10	10		31	3–31%
Economic Insects.....	45	25	40	5	20		12	38	14	70	5	32	5–70%
Collection, Preservation, etc.....	6	15	15	5	*	35	5	18	4	*	20	10	4–35%
History of Entomology.					*				5				0–5%
Review.....	8				*								0–8%

*Taught as a part of another course division.

**Difficult to separate as a distinct course division.

Mississippi builds his first course entirely around the collection and indentification of insects, not only because he believes in arousing the acquisitive instincts of the students, but because of favorable weather conditions in Mississippi during much of the time the course is taught. Professor Metcalf of the University of Illinois is forced to devise a different method of bringing the actual insects to the students, that of building up an immense series of individual sets of prepared insects. Weather conditions at Champaign are unfavorable to field work during most of the teaching season.

The accompanying table gives a comparison of the elementary course as taught in 12 institutions in as many states. It is taken from percentages outline furnished the author by the instructor in charge. It is impossible to give exact figures on the amount of time devoted to the different phases of entomology, but the tabulation will give a fairly good idea of the variety of possibilities.

A DIGEST OF ADDITIONAL EXPERIMENTS IN THE APPLICATION OF PARADICHLOROBENZENE IN SOLUTION AGAINST THE PEACH BORER

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ABSTRACT

Additional experiments with paradichlorobenzene dissolved in high-test gasoline and applied around the bases of the peach trees were conducted in the spring and fall of 1927. Results of the tests appear to indicate that the solution form of treatment, even without preparation of the soil before treatment and without banking with soil following the application, is as effective as the application of the crystals made in the usual way. The use of varying proportions of the solvent in excess of 50 c.c. to 1 ounce of paradichlorobenzene apparently decreases the efficiency of the treatment.

In 1926 the writers reported on experiments with applications of paradichlorobenzene in solution form[1] to control the peach borer, *Aegeria exitiosa* Say. High-test gasoline was selected from the several solvents tested as suitable for use because it was thought to be more practical from the standpoint of cost and availability.

Preliminary experiments were made in the fall of 1926[2] in a peach orchard near Ednor, Maryland. The results of these tests indicated that paradichlorobenzene in solution was as effective as the crystalline form

[1]In all of the tests in 1926 and 1927 the solution of paradichlorobenzene was applied by means of a glass separatory funnel.

[2]Siegler, E. H., and Brown, Luther. Preliminary experiments in the application of paradichlorobenzene in liquid form against the peach tree borer. Jour. Econ. Ent., Vol. 20, No. 5, pp. 701–702, October, 1927.

now recommended when applied in a comparable way. In these tests the soil was first prepared for the reception of the insecticide and subsequently banked to prevent the escape of the volatile paradichlorobenzene.

Encouraged by the results of the work in 1926, the writers planned and carried out additional experiments in the same orchard in the spring and fall of 1927. The procedure in these experiments differed from that in the preliminary work in 1926 in that some of the tests were made without preparation of the soil before the application of the paradichlorobenzene and without resorting to banking with soil after the treatments. It was obvious that considerable labor could be eliminated if it were possible to dispense with the soil preparation before treatment and the subsequent banking. Plats treated with the crystalline form of the chemical were checked against others in which the chemical in solution was applied as above described. Data from untreated check plats were included with the final results as a further comparison with the treated plats. Varying proportions of gasoline and paradichlorobenzene were tried in the fall tests of 1927.

The spring tests of 1927 consisted of four treated plats and one check plat of ten trees each, the insecticide in each case being applied in a ring about 1½ inches from the trunk. The results obtained, and other data in connection with the plats, are given in Table 1.

TABLE 1. COMPARATIVE RESULTS FROM THE APPLICATION, AT A DISTANCE OF 1½ INCHES FROM THE TRUNK, OF PARADICHLOROBENZENE CRYSTALS AND OF SOLUTION OF PARADICHLOROBENZENE IN HIGH-TEST GASOLINE AGAINST THE PEACH BORER. TREATED APRIL 16, 1927; EXAMINED MAY 18, 1927.

Plat No.	Paradichlorobenzene Dosage per Tree	Soil Preparation	Treatment of soil After Application	Number of Larvae Found	
				Dead	Alive
I	1 oz. to 50 c.c. gasoline	Soil slightly prepared	Soil not banked	1	18
II	1 oz. crystals	do	Soil slightly banked	3	20
III	1 oz. to 50 c.c. gasoline	do	do	8	20
IV	1 oz. crystals	do	Soil not banked	0	42
V	Not treated (check)			0	27

A study of Table 1 shows that poor control resulted in all the treated plats. The results obtained in plats I and II are somewhat similar. It will be noted that plats I and IV were treated in a comparable way, with somewhat superior results in plat I. The results of the spring tests

reveal that the use of paradichlorobenzene in solution with slight soil preparation, and with or without subsequent banking, gave results not essentially different from those following the application of the crystals in a like manner.

The experiments made in the fall of 1927 embraced tests in which different proportions of gasoline and paradichlorobenzene were used. In order to present the conclusions drawn from these tests, it is necessary to separate the plats into two groups because of a slight change in the manner of applying the treatments. The first group consists of six plats treated on the same day, and one check plat. In these tests efforts were made to pour the solution of paradichlorobenzene in a circle about two inches from each tree trunk. The results of these tests are given in Table 2.

The second group of plats treated in the fall of 1927 consisted of six treated plats of ten trees each. The liquid in the treatments of this section was applied in a circle about one inch from each tree trunk. Table 3 gives the details and the results of the treatments in the second group.

In Table 2 it will be noticed that in plat II, without previous soil preparation and without subsequent banking, and in plat VI, without soil preparation but with slight subsequent banking, similar results i.e., an absence of live larvae after treatment were obtained as in plat I treated with the crystals in the usual manner. In plat III, which was treated with crystals without soil preparation and without subsequent banking, no dead larvae were found, and the total number of live larvae exceeded the total number in check plat VII. (Similar results appear in plat IV of Table 1.) A further study of Table 2 will reveal that an increase in the quantity of gasoline apparently lowers the effectiveness of the treatment (compare plat II with plats IV and V, Table 2).

In those cases in which larger proportions of gasoline than 50 c.c. to the ounce of crystals were used the results are different in Table 3 from those in Table 2. The plats so treated in Table 3 showed a better control than plats similarly treated in Table 2. The improvement in control in Table 3 is accounted for on the assumption that the closer application of the treatment increased the concentration of gas immediately around the bases of the trees. However, when one ounce of paradichlorobenzene crystals was dissolved in 200 c.c. of gasoline, as shown in plat V of Table 3, the results were not so favorable.

After comparing the application of paradichlorobenzene in solution with the application of the insecticide in crystal form, the writers believe

TABLE 2. COMPARATIVE RESULTS FROM THE APPLICATION, AT A DISTANCE OF 2 INCHES FROM THE TRUNK, OF PARADICHLOROBENZENE CRYSTALS AND OF A SOLUTION OF PARADICHLOROBENZENE IN HIGH-TEST GASOLINE AGAINST THE PEACH BORER; FALL OF 1927

Plat No.	Date Treated	Date Examined	Paradichlorobenzene Dosage per Tree	Soil Preparation	Treatment of Soil After Application	Larvae Found Dead	Larvae Found Alive
I	Sept. 27	Nov. 10	1 oz crystals	Soil prepared	Soil banked	0	0
II	do	do	1 oz. to 50 c.c. gasoline	Soil not prepared	Soil not banked	8	0
III	do	Nov. 12	1 oz. crystals	do	do	0	32
IV	do	Nov. 14	1 oz. to 100 c.c. gasoline	do	do	2	6
V	do	do	1.5 ozs. to 100 c.c. gasoline	do	do	6	5
VI	do	Nov. 15	1 oz. to 50 c.c. gasoline	do	Soil slightly banked	4	0
VII			Not treated (check)			0	22

TABLE 3. COMPARATIVE RESULTS FROM THE APPLICATION, AT A DISTANCE OF 1 INCH FROM THE TRUNK, OF PARADICHLOROBENZENE CRYSTALS AND OF A SOLUTION OF PARADICHLOROBENZENE IN HIGH-TEST GASOLINE AGAINST THE PEACH BORER; FALL OF 1927.

Plat No.	Date Treated	Date Examined	Paradichlorobenzene Dosage per Tree	Soil Preparation	Treatment of Soil After Application	Larvae Found Dead	Larvae Found Alive
I	Sept. 30	Nov. 15	1 oz. crystals	None	Soil slightly banked	9	1
II	do	Nov. 19	1 oz. to 50 c.c. gasoline	do	Soil not banked	6	1
III	do	Nov. 22	1 oz. to 150 c.c. gasoline	do	do	2	0
IV	do	do	1.5 ozs. to 150 c.c. gasoline	do	do	13	0
V	do	do	1 oz. to 200 c.c. gasoline	do	do	5	8
VI	do	Nov. 19	1.5 ozs. to 200 c.c. gasoline	do	do	4	0

that the minimum quantity of high-test gasoline (1 ounce of crystals to 50 c.c. of gasoline) is more effective than increased quantities of the solvent, because of a greater increase in the concentration of gas around the bases of the trees. This greater concentration of volatile paradichlorobenzene is thought to be due to the fact that the smaller quantity of the solvent does not penetrate to so great a depth or spread laterally to such an extent before recrystallization of the paradichlorobenzene as would happen with the use of larger proportions of gasoline. With the small quantity of gasoline the newly formed crystals are deposited at the best location for control.

It has been observed, in all the tests with the solution in comparison with the crystals, that at the time of examination, all the finely divided crystals resulting from the liquid treatments were completely volatilized, and with the crystal application a considerable quantity of the paradichlorobenzene was still visibly present in the soil.

No injury has been recognized from the application of paradichlorobenzene in solution to peach trees six and seven years old.

Although it is recognized that additional work is necessary to establish the hypotheses herein summarized, further experimentation may show the possibility of substituting the solution application for the present method of treatment, thereby reducing the attendant labor now required in peach-borer control.

TOXICITY OF LEAD SALTS TO INSECTS

By Floyd John Brinley, *Zoological Laboratory, University of Pennsylvania*[1]

Abstract

Lead oxide (PbO), lead carbonate, lead sulfate, and lead chromate are slow acting toxic compounds for tent caterpillars. The order of toxicity is as follows: Chromate>sulfate>carbonate>oxide. There appears to be a direct relationship between toxicity and the molecular weight; an increase in molecular weight increases toxicity.

The amount of lead in the body of the insect at the time of death, exclusive of digestive tract, per milligram of body weight, remains constant regardless of the amount of lead oxide eaten.

Considerable attention has been given to studies on the toxicity of lead arsenate to insects. Particular attention has been paid to the role of the arsenic while the base seems to have been largely neglected. Because of this lack of data it was deemed advisable to study the toxicity of lead to certain insects. The present study is an attempt to

[1]This work was done in part while the author was associated with the Bureau of Entomology, U. S. Department of Agriculture.

furnish some data on the toxicity of certain lead salts to tent caterpillars.

Method

The fact that tent caterpillars, *Malacosoma americana*, are rapid feeders, consume large amounts of foliage, are easily handled and readily obtained, suggests that they might be favorable material for use in lead toxicity experiments.

In determining the toxicity of any compound, two factors must be considered: (1) the amount of poison actually eaten and (2) the time required for the organisms to die after consuming the poison. The amount of poison eaten, however, does not necessarily represent the amount that is required to kill, since some of the material passes through the digestive tract and is egested while a certain amount is usually found in the digestive tract at the time of death and thus does not enter directly into the killing of the insect.

To determine the amount of poison eaten the following method was devised: one large leaf of wild cherry, attached to a small branch, was treated with ten milligrams of the chemical. The compound was carefully and evenly spread with a flexible spatula over the dorsal surface of the leaf. With care and practice this can be accomplished with no injury to the leaf. After being treated, the leaf was placed in a vial of water in a small wire screen cage. One caterpillar was introduced into a cage and allowed to feed on the leaf. At the beginning of the experiment the leaf was traced on tracing paper and its area calculated by measuring the traced area with a planimeter. The amount of poison per unit area of the leaf was computed. After the death of the insect or at the close of the experiment the leaf was retraced and the area eaten determined. The product of the eaten area by the amount of the poison per unit area gives the amount of poison consumed. The time between the first feeding and death and the time elapsing between the last feeding and death were determined. The following C. P. lead salts were used and will be discussed separately; lead oxide (PbO); lead carbonate ($Pb\ C\ O_3$); lead chromate ($Pb\ Cr\ O_4$); and lead sulfate ($Pb\ S\ O_4$).

Lead Oxide (Pb O)

Twenty-three tests with lead oxide were conducted.

The results show that the average amount of foliage eaten per animal was 16.99 sq. cm. and the average amount of lead oxide consumed was 4.98 mg. The average time elapsing between the first feeding and death was 8.7 days, while only five days elapsed between the last feeding and death. It was also noted in a large majority of cases that the insect consumed more than one meal before death occurred.

A number of the caterpillars were analyzed to determine the relation between the amount of lead oxide eaten and the amount of lead within the body of the insect at the time of death. The method of analysis used was that given by Fairhall,[2] a brief extract is as follows: the ash is dissolved in dilute hydrochloric acid, the solution neutralized with sodium hydroxide using methyl orange as an indicator, and then slightly acidified with hydrochloric acid. Lead is precipitated as the sulfide with hydrogen sulfide. The precipitate is washed with boiled water and dissolved in concentrated nitric acid, then boiled to expel excess hydrogen sulfide. After neutralizing with sodium hydroxide and slightly acidifying with acetic acid, an excess of potassium chromate is added and the solution boiled. The precipitate is washed in hot water and dissolved in dilute hydrochloric acid followed with hot water and an excess of potassium iodide added to the solution which is titrated with .005 N sodium thiosulfate.

Table 1 gives a summary of the results obtained from analysis of caterpillars used in experiment with Pb O.

TABLE 1. AMOUNT OF LEAD FOUND IN ENTIRE BODY OF THE INSECT AT TIME OF DEATH.

Exp. No.	Wt. of Insect	Amt. of PbO Eaten	Amt. of Lead in Body	Amt. of Lead per mg. of Body Wt.
	mg.	mg.	mg.	
4	375	5.47	.173	.00046
3	140	0.70	.131	.00093
1	166	3.00	.090	.00054
5	119	4.15	.214	.00019
21	247	0.79	.024	.00010
24	345	3.53	.115	.00033
13	892	12.96	.422	.00043
			Average	.00043

AMOUNT OF LEAD FOUND IN BODY OF THE INSECT AFTER THE DIGESTIVE TRACT WAS REMOVED.

33	145	2.24	.018	.00012
30	—	6.00	.028	—
27	182	0.69	.018	.00010
28	—	6.66	.020	—
29	139	.56	.015	.00011
32	90	3.55	.020	.00022
13	892	12.96	.109	.00012
			Average	.00011

[2]Fairhall, L. T. J. Ind. Hyg. 4, No. 1, 9–20, 1922.

It may be noted from this table that when the entire body of the insect was analyzed the amount of lead within the body at the time of death per milligram of body weight varied from .0001 mg. to .00093 mg. with an average of .00043 mg. However, when the body exclusive of the alimentary canal was analyzed the amount of lead per unit weight of the insect varied from .00010 mg. to .00022 mg. with an average of .00011 mg. It thus seems that after the alimentary canal is removed, the amount of lead found in the body remained constant regardless of the quantity of lead oxide eaten. Therefore, it is apparent that a definite amount of lead must be absorbed by the insect from the alimentary canal before death occurs and that after death no more is absorbed. The amount of lead in the alimentary canal at the time of death does not enter into the killing of the animal.

Lead Carbonate ($Pb\ C\ O_3$)

Twenty-three experiments were conducted with lead carbonate.

The average area of foliage consumed per larva was 15.83 sq. cm. representing 4.29 mg. of lead carbonate. Between the first feeding and death 7.7 days elapsed, while between the last feeding and death 3.9 days elapsed. In comparison with the oxide, less material was consumed and the insect died in a shorter period of time after eating. With the carbonate as with the oxide more than one meal was consumed by the insect before death occurred.

Lead Sulfate ($Pb\ S\ O_4$)

Twnety-seven tests were conducted with lead sulfate.

The results show that the average amount of lead sulfate consumed per larva was 1.38 mg. Between the first feeding and death 8.7 days elapsed, while between the last feeding and death 4.6 days elapsed. With the sulfate as with the oxide and carbonate more than one feeding was required to produce death. The insects ate for an average of four days between the first and last feeding. The amount of sulfate consumed was less than the oxide or the carbonate. The sulfate, judging from the time of death of the organisms, may be considered to be slightly more toxic than the oxide or carbonate.

Lead Chromate ($Pb\ Cr\ O_4$)

Twenty-eight tests were conducted with lead chromate.

The caterpillars consumed an average of 0.507 mg. of lead chromate. Between the first feeding and death the time was 7.1 days, while between the last feeding and death it was 5.5 days. This shows that little or no time elapsed between the first and last feeding, or that the insects consumed at one feeding a lethal amount of the chromate.

Six control tests were conducted to determine the normal rate of feeding and the amount of foliage consumed. The tests were conducted as with the lead salts except that the leaves were not treated. In some cases the larva consumed more than one leaf.

The average area of foliage consumed per larva in the control tests was 27.735 sq. cm. in an average time of 8.1 days as compared with 15.99 sq. cm. in 8.7 days with lead oxide; 15.838 sq. cm. in 7.7 days with lead carbonate; 8.9 sq. cm. in 8.7 days with lead sulfate; and 1.77 sq. cm. in 7.1 days with the chromate. In no experiment did the insects eat as much of the foliage as did the controls.

The lead salts used, namely, chromate, sulfate, carbonate, and oxide proved to be definitely toxic to tent caterpillars. The order of toxicity is as follows: chromate⟩ sulfate⟩ carbonate⟩ oxide. The slowness of action of the compounds may be due to their slow penetration through the walls of the alimentary tract. The toxicity of the lead salts is apparently not dependent upon their solubility in water nor is it due to the percentage of lead in the compound. (Table No. 2.) There seems to be, however, a direct relationship between the molecular weight and toxicity. Thus the size of the molecule may be a factor in determining toxicity.

TABLE 2.

Compound	Solubility in gms.* in 1000 c.c. of H_2O	% Lead in Compound	Molecular Weight
Chromate	.0001	64	323.3
Sulfate	.040	68	303.2
Carbonate	.0011	77	267.2
Oxide (PbO)	.068	91	223.6

SUMMARY

Lead oxide, lead carbonate, lead sulfate and lead chromate are slow acting toxic compounds for fall webworms. The order of toxicity is as follows: chromate⟩ sulfate⟩ carbonate⟩ oxide.

There appears to be a direct relationship between toxicity and molecular weight; an increase in molecular weight increases toxicity.

The amount of lead in the body of tent caterpillars at the time of death, exclusive of the digestive tract, remains constant regardless of the amount of Pb O eaten.

INSECTICIDAL TESTS WITH OILS AND ALKALOIDS OF LARKSPUR (*DELPHINIUM CONSOLIDA*) AND STAVESACRE (*DELPHINIUM STAPHISAGRIA*)

By W. M. DAVIDSON, *Assoc. Entomologist, Food, Drug and Insecticide Administration, U. S. Department of Agriculture*

ABSTRACT

Tests with oils and alkaloids of *Delphinium consolida* and *D. staphisagria* demonstrated that the seeds of these plants have insecticidal properties. The oils in the form of soap emulsions were highly toxic to red spiders and aphids. The alkaloids from *D. consolida* were highly toxic to aphids and thrips, ineffective against red spiders, and of value as stomach poisons against certain leaf-feeders. The alkaloid from *D. staphisagria* was much less toxic. The insecticidal value of these products was found to be weakened from the fact that the margin of safety on plant tissues was small. In the case of red spiders, at least, this margin is apparently sufficient.

The tests here reported are of a preliminary nature, and were undertaken for the purpose of determining the toxic values of the ingredients of *Delphinium consolida* and *Delphinium staphisagria*, in order to assist in the examination of preparations on the market containing these products.

The alkaloids of larkspur and stavesacre are known to be toxic to certain forms of lice parasitic on vertebrates but no information was available on their action to other species of insects. The tests here described were conducted on sucking and chewing insects and other arthropods at the Administration's field laboratory at Vienna, Virginia.

LARKSPUR OIL

The sample of larkspur oil used in these tests was prepared by L. N. Markwood from the seeds of *Delphinium consolida* (1).[1] The yield of oil was 25 per cent of the total weight of the seed (1 c.). Since the oil is insoluble in water it was necessary for spraying purposes to make an emulsion of it, soap being used for this purpose. Either laundry soap or fish oil soap was dissolved at the rate of one pound to 100 gallons of water and the desired amount of oil agitated with the diluent and immediately applied to the insects. Tests were made with the soap solution alone as a check, in addition to the untreated check.

[1]L. N. Markwood. The Isolation and Properties of the Alkaloids and Oil of Larkspur Seed (*Delphinium consolida*). Jour. Amer. Pharm. Assoc., XIII, 8, p. 696, August (1924).

Tests on Arthropods

Red Spiders. Sprayed on infested celery plants in a greenhouse a .5 per cent emulsion[2] killed 87 per cent of the active forms and 75 per cent of the eggs of *Tetranychus telarius* L. A one per cent emulsion killed all of the active forms and 85 per cent of the eggs, and a 2 per cent emulsion killed all the active forms and more than 90 per cent of the eggs. No foliage injury resulted within two weeks at the lower dilutions and only superficial injury was caused by the emulsion containing 2 per cent of oil. These tests were made at temperatures ranging from 75 to 80 degrees Fahrenheit. Laundry soap alone gave a mortality of three per cent of the active forms.

Field tests were made against the same species of insects on hollyhock plants. A 1 per cent emulsion of the oil with fish oil soap killed 97 per cent of the active forms and 75 per cent of the eggs. A 2 per cent emulsion with fish oil soap and laundry soap killed 99 per cent and 100 per cent of the active forms and 75 per cent of the eggs. The older leaves of the plants were scorched by the weaker emulsion and rather severely scorched by the 2 per cent emulsion but no permanent injury resulted to the growing plants. A mortality of 7 per cent of the active red spiders occurred on the unsprayed checks.

Against *Paratetranychus pilosus* C. & F. on apple in a greenhouse a 2 per cent emulsion with laundry soap killed over 99 per cent of the young nymphs and 88 per cent of the eggs.

Aphids. Tested against *Aphis rumicis* L. on nasturtium plants in a greenhouse a .5 per cent emulsion with soap was quite inefficient, while a 1 per cent emulsion killed 78 per cent and 2 per cent emulsion killed 94 per cent. Superficial foliage injury resulted from the 2 per cent oil. Laundry soap alone killed only 2 per cent of the aphids.

A 2 per cent emulsion killed 99 per cent of *Myzus persicae* Sulz. on cabbage with injury to the host plant. Soap alone killed but 1 per cent of the aphids.

Field tests were made against *Macrosiphum rosae* L. on rose: 1 per cent emulsion with fish oil soap killed 80 per cent, and 2 per cent emulsion 99 per cent, of the aphids. Severe blotching of the leaves resulted from the 2 per cent emulsion. A 2 per cent emulsion with soap killed 99 per cent of *Myzus cerasi* Fabr. on sour cherry and caused no injury to the foliage.

Thrips. In a greenhouse 2 per cent and 3 per cent emulsions failed to control *Thrips tabaci* Lind. on beans. Slight foliage injury resulted from the 3 per cent emulsion.

[2].5% oil. References below to "1% emulsion," "2% emulsion," etc. should be construed to indicate 1% oil, 2% oil, etc.

WHITE FLY. A 2 per cent emulsion was inefficient against *Aleyrodes vaporariorum* West. under greenhouse conditions, while a 3 per cent concentration killed the larvae and 70 per cent of the pupae but did not prevent eggs from hatching. Laundry soap alone was entirely ineffective. Some foliage injury to nasturtium and string bean resulted from the oil.

OTHER ARTHROPODS. Red scale (*Chrysomphalus* sp.) on palms in a greenhouse were sprayed with a 2 per cent emulsion resulting in a scale mortality of 78 per cent, while unsprayed plants showed a 57 per centmortality and plants sprayed with soap alone 59 per cent mortality of the scale.

Currant bushes infested with San José scale (*Aspidiotus perniciosus* Coms.) were sprayed with a 2 per cent emulsion at a temperature of 43°F.: Counts indicated a scale mortality of 95 per cent as against one of 86 per cent for the checks.

A 1 per cent emulsion did not prevent the hatching of sprayed eggs of Tent caterpillars (*Malacosoma americana* Harris). A 2 per cent concentration was inefficient when sprayed on sow-bugs (Isopoda). A similar strength used as a contact was inefficient against the larvae of the potato bug (*Doryphora decemlineata* Say) and the larvae of cabbage worms (*Pontia rapae* L. and *Evergestis rimosalis* Guen).

FOLIAGE TESTS

Field tests on foliage were made with 1 per cent and 2 per cent concentrations of oil with fish oil soap. The 1 per cent emulsion was sprayed on a partly cloudy day on tomato, lima and string beans, plum (*domestica* type), sweet cherry, apple and peach, with no resultant injury in any case. The 2 per cent concentration was sprayed in sunny weather on tomato, lime and string beans, Japanese and *domestica* plums, apple and peach, and no injury resulted except to lima bean, on which there was some discoloration of the older leaves but no lasting effect. Hollyhock as previously noted was injured by the 1 per cent emulsion and both hollyhock and rose foliage by the 2 per cent emulsion.

STAVESACRE OILS

The samples of oils used in these tests were isolated from the seed of *Delphinium staphisagria*[3]. In the process of this extraction two isolations of the pure oil were obtained, termed respectively "first lot" and "second lot." Both were tested and are considered together in the

[3]L. N. Markwood. "Isolation of the Oil and Alkaloids of Stavesacre Seed (*Delphinium staphisagria*)." Jour. Amer. Pharm. Assoc., XVI, 10, p. 928 (1927).

descriptions of the tests since practically no difference in insecticidal values were found between these two lots. These tests were made in the same manner as those with larkspur oil, either laundry or fish oil soap being used as the emulsifying agent at a strength of 1 pound to 100 gallons. All applications were made immediately after the oil and soap solutions were combined.

Tests on Arthropods

Red Spiders. Against *Tetranychus telarius* a .5 per cent concentration was valueless; a 1 per cent emulsion killed 96 per cent to 99 per cent of the active forms and more than 50 per cent of the eggs, and a 2 per cent emulsion killed 98 per cent to 99 per cent of both active forms and eggs. No injury to celery plants under greenhouse conditions occurred. Laundry soap alone killed but 3 per cent of the active forms. Sprayed on hollyhock in the field there was a mortality of active red spiders of 91 per cent and 99 per cent in two tests and about 75 per cent of the eggs were killed. The older leaves of the hollyhock plants were extensively spotted and blotched, but otherwise the plants were not injured.

On apple branches in a greenhouse a 2 per cent concentration killed 95 per cent of the young nymphs of *P. pilosus* and 60 per cent of the eggs. From observations made on check branches the natural mortality of the eggs was 16 per cent.

Aphids. In a greenhouse a .5 per cent emulsion with soap was inefficient and a 1 per cent emulsion killed from 83 per cent to 94 per cent of *Aphis rumicis* on nasturtium plants. Two per cent emulsion killed from 95 per cent to 98 per cent of this aphid, and caused but slight injury to the foliage. On cabbage plants mortality of 98 per cent and 99 per cent was secured in two tests against *Myzus persicae* with no injury to the plants. Soap alone killed 2 per cent of *A. rumicis* and 1 per cent of *M. persicae*.

In the field only the 2 per cent concentration was used and this gave a 98 per cent kill of the large rose aphid (*M. rosae*), while 99 per cent of the cherry aphid (*M. cerasi*) were destroyed. Rose foliage was spotted extensively and sweet cherry foliage was scorched and discolored but no actual defoliation resulted. The oil also killed 95 per cent of a colony of the green apple aphis (*Aphis pomi* DeGeer) without injury to apple foliage.

Thrips. Two per cent emulsion was inefficient when sprayed on *Thrips tabaci* on cabbage and nasturtium plants in a greenhouse. Three per cent emulsion was of some value but scorched the foliage of string bean plants.

WHITE FLY. Two per cent emulsion killed the young larvae of the white fly (*A. vaporariorum*) but not the older larvae nor the eggs. Three per cent killed all the larvae and about three-fourths of the pupae, but badly scorched nasturtium foliage.

OTHER ARTHROPODS. Red scale (*Chrysomphalus*) on palms in a greenhouse were sprayed with 2 per cent emulsion: Later observations showed that 90 per cent and 92 per cent of the scales on the sprayed plants were dead. On the check plants the mortality was 57 per cent.

The eggs of tent caterpillars (*M. americana*) sprayed with 1 per cent emulsion were not killed.

As a contact spray 2 per cent emulsion was inefficient against sow bugs (Isopoda), large larvae of potato bugs (*D. decemlineata*), and cabbage worms (*P. rapae* and *E. rimosalis*).

FOLIAGE TESTS

Field tests on foliage were made with 1 per cent and 2 per cent concentrations with fish oil soap. The foliage of tomato, lima and string beans, apple, peach and sweet cherry was not injured by the 1 per cent concentration in sunny or partly cloudy weather. The 2 per cent concentration did not injure tomato, Japanese and domestica plums, apple and peach, but slight scorching of the leaves of string beans and somewhat more pronounced injury to lima beans resulted, both in sunny and partly cloudy weather. This injury was not permanent nor severe enough to defoliate. The foliage of sweet cherry, rose and hollyhock was scorched by 2 per cent emulsion.

ALKALOIDS

Two crystalline alkaloids, Delcosine and Delsoline, isolated from the seeds of *Delphinium consolida* by L. N. Markwood (1) were prepared in concentrations of 0.83 per cent Delcosine and 0.63 per cent Delsoline respectively in dilute alcohol.

DELCOSINE. Delcosine was tested at various dilutions both with water alone as diluent and with the addition of laundry soap at the rate of one pound to 100 gallons. The added soap increased its effectiveness as a contact spray, although the soap solution alone at this strength is practically valueless as an insecticide.

A solution containing 0.017 per cent of the alkaloid in water was, under greenhouse conditions, inefficient when sprayed on *Aphis rumicis* on nasturtium and on *Myzus persicae* on cabbage. It killed less than 30 per cent of *Thrips tabaci*. No injury to plant tissues resulted.

A solution of this strength with soap added killed under the same conditions 70 per cent of *Aphis rumicis* on nasturtium, 94 per cent of *Myzus persicae* on cabbage, and 85 per cent of *Thrips tabaci* on string bean. White fly larvae (*A. vaporariorum*) were uninjured. No injury resulted to plant tissues.

A solution containing 0.042 per cent of the alkaloid in water killed 97 per cent of *A. rumicis* and 81 per cent of *Thrips tabaci*, but not over 5 per cent of red spider (*T. telarius*). When the larvae of fall web worms (*H. cunea*) were placed on sprayed apple foliage, they fed only slightly and eventually died.

A solution of this strength with the addition of soap killed 99 per cent of *A. rumicis* on nasturtium within 6 days (95 per cent in 3 days), and 99 per cent of *Myzus persicae* on cabbage within 6 days (97 per cent in 3 days). Not over 12 per cent of red spiders were killed in 9 days. No injury to plant tissues resulted.

When a solution containing 0.085 per cent of the alkaloid with water was sprayed on apple foliage, fall web-worm larvae placed thereon refused to feed and subsequently died. Larvae of the cabbage looper (*Autographa brassicae* Riley) placed on sprayed cabbage plants fed without injury but larvae of *Pontia rapae* were killed .

The same strength solution with soap killed all of *A. rumicis* and *M. persicae* on nasturtium and cabbage without injury to the plants. Under greenhouse conditions, 98 per cent of *Thrips tabaci* on string beans were killed in three days, but no effect was observed on white fly larvae and pupae (*A. vaporariorum*), nor did there result an appreciable control of red spider (*T. telarius*). Against the celery thrips (*Heliothrips femoralis* Reuter), a resistant species, not over 60 per cent of the larvae were killed. The spray was also ineffective against the citrus mealy bug (*P. citri* Risso). Celery and string beans were not injured by the spray.

DELSOLINE. The stock delsoline solution was tested after further dilution with water with and without the addition of soap (1 pound to 100 gallons).

A solution containing 0.042 per cent of the alkaloid, without soap, killed 85 per cent of *Aphis rumicis* on nasturtium and 65 per cent of *Myzus persicae* on cabbage, but did not injure red spider (*T. telarius*). With soap, 100 per cent of *A. rumicis* were killed in 6 days (94 per cent in 3 days), 98 per cent of *M. persicae* were killed in 6 days (90 per cent in 3 days), but red spiders and larvae of white fly (*A. vaporariorum*) were not affected.

A solution containing 0.085 per cent of the alkaloid with soap killed 99 per cent of *A. rumicis* and 100 per cent of *M. persicae* in four days. The foliage of nasturtium was slightly injured. White fly pupae and red spiders were not affected. Adults and larvae of *Thrips tabaci* on string bean plants were all killed, without injury to the plants.

When apple foliage was sprayed with the same strength solution without soap and large fall web-worm larvae were placed thereon the worms did little feeding and subsequently died, Cabbage worms (*P. rapae*) when placed on sprayed cabbage plants exhibited similar behaviour. Large larvae of the Tiger Moth (*Diacrisia virginica* Fabr.) fed normally on sprayed string bean foliage and were uninjured.

DELPHININE. This alkaloid was isolated from seeds of *Delphinium staphisagria* (2). The material furnished for the tests was a solution of delphinine hydrochloride in alcohol containing 0.63 per cent alkaloid. This solution was further diluted with water, or water and soap, for use in the experiments.

A solution containing 0.042 per cent of the alkaloid applied as a spray on cabbages infested with *Myzus persicae* and on beans infested with *Thrips tabaci* had little effect on the insects and did not injure plant tissues. Small larvae of fall web-worms fed normally on sprayed apple branches. Young cabbage worms (*P. rapae*) placed on sprayed cabbage plants at first fed normally but later ceased feeding and eventually died.

A solution containing 0.085 per cent of the akaloid used as a contact spray was inefficient against *Myzus persicae*, but 89 per cent of the larvae of *Thrips tabaci* were killed. When cabbage worms (*P. rapae*) were placed on sprayed cabbage plants they fed little and ultimately died. Fall web-worm larvae placed on sprayed plum foliage fed heavily but their growth was retarded. No injury to hollyhock, string bean, cabbage or plum foliage resulted.

This concentration with soap was inefficient under greenhouse conditions against the spinach aphid, *Myzus persicae*, mealy-bugs, red spiders and the greenhouse thrips *Heliothrips femoralis*, and was efficient as a stomach poison against cabbage worms, (*Pontia rapae*).

A solution containing 0.16 per cent of the alkaloid with soap (1 pound to 100 gallons) gave similar results. It was also inefficient as a stomach poison against fall web-worm larvae. There was no injury to the foliage of celery or cabbage.

SUMMARY

Larkspur and Stavesacre oil emulsions were tested as contact sprays against a number of arthropods of economic importance. Very good

efficiency was secured on red spiders;—two per cent emulsions gave satisfactory control and one per cent had a considerable effect.

A two per cent concentration was effective against five species of aphids, but of little value against thrips, sow-bugs, potato bug and cabbage worm larvae. Young larvae of the greenhouse white fly were killed, but other stages proved resistant, while only a fair degree of control resulted when a three per cent emulsion was used and severe injury to foliage occurred. Two per cent emulsion was of value against red scale in a greenhouse and of lesser value against San Jose scale in the field.

Foliage tests indicated that the margin of safety is very narrow. One per cent emulsion caused slight injury to hollyhock foliage, but did not injure beans, tomatoes nor fruit trees. Two per cent emulsion did not injure apple, plum, peach, sour cherry or tomato, but scorched in varying degree beans, sweet cherry, rose and hollyhock foliage. Under greenhouse conditions cabbage plants were unhurt by two per cent emulsion while celery and nasturtium suffered superficial injury.

The alkaloids delcosine, delsoline and delphinine were tested as sprays, with and without soap, both as contact and stomach poison insecticides. The added soap (1 pound to 100 gallons) increased considerably the efficiency of these solutions.

A 0.042 per cent solution of Delcosine was effective in a greenhouse against aphids, of value against *Thrips tabaci* but valueless against red spiders. A 0.085 per cent solution controlled aphids and *Thrips tabaci*, but was only moderately efficient against *Heliothrips femoralis*, and of no value against mealy-bugs and greenhouse white-fly. Larvae of the Fall web-worm placed on apple foliage sprayed with 0.042 per cent and 0.085 per cent solutions of delcosine failed to feed normally and subsequently died. Larvae of the cabbage worm (*Pontia rapae*) when placed on cabbage foliage sprayed with 0.085 per cent delcosine solution died; those of *Autographa brassicae*, however, fed and transformed normally. Delcosine did not injure foliage at the concentrations used.

A 0.042 per cent solution of Delsoline was effective in a greenhouse against aphids, but ineffective against red spiders and white fly. A 0.085 per cent solution was effective against aphids and *Thrips tabaci*, but inefficient against red spiders and white fly. Fall web-worms and cabbage worms (*P. rapae*) died after feeding on sprayed foliage, but large larvae of a Tiger Moth were unhurt. Nasturtium foliage was slightly scorched.

Delphinine hydrochloride at concentrations up to 0.16 per cent of alkaloid was inefficient with or without soap against the aphid *Myzus*

persicae, mealy-bugs, red spiders and *Heliothrips femoralis* in a greenhouse, and did not prevent fall web-worm larvae from feeding normally. A 0.085 per cent solution was of value against *Thrips tabaci*. It was also effective as a stomach poison against larvae of cabbage worms (*P. rapae*). Delphinine hydrochloride did not injure foliage at the concentration used.

Conclusions

Experiments have shown that the oils and alkaloids of *Delphinium consolida* and *Dephinium staphisagria* are active as insecticides. Both the oils and alkaloids have value as contact insecticides and the latter are indicated as stomach poisons.

BENTONITE AS A DUST CARRIER FOR NICOTINE

By L. R. Streeter, *Associate Chemist, New York State Agricultural Experiment Station, Geneva, N. Y.*

It is quite generally recognized that a good dust carrier for nicotine should increase the rate of volatility of the nicotine making the dust more active as a contact insecticide. Certain clay fillers somewhat colloidal in nature have been found to adsorb nicotine and prevent or retard its volatility. Bentonite is known to possess remarkable adsorbing powers and might be expected to retard the volatility of nicotine from dust mixtures.

While working with bentonite as a dust carrier for nicotine, Hixon and Drake report large losses of nicotine which could not be accounted for and which could not be attributed to volatility. A bentonite-nicotine dust was reported to have lost from 23 to 86 per cent of its nicotine in 24 to 48 hours when kept in tightly stoppered bottles. They further report an unaccountable loss of 91 per cent in nicotine content when a current of air was drawn thru the dust in a specially constructed apparatus for testing volatility of nicotine dust mixtures. They attributed these losses to decomposition of the nicotine. When the physical nature of the filler and the stability of nicotine sulfate are considered, such rapid decomposition seems impossible.

The above consideration seemed to warrant further investigation, and accordingly, several dust mixtures were prepared using bentonite and nicotine sulfate. In determining the nicotine content of the dusts used the nicotine was recovered from the dust by steam distillation.

A dust containing 3.14 per cent nicotine was spread out in a thin layer and left exposed to the air for 2, 6, 12, and 21 days. At the end of these intervals samples were taken for analysis with the following results: 3.11 per cent, 3.15 per cent, 3.11 per cent, and 3.12 per cent of nicotine, respectively.

Another mixture containing 2.75 per cent of nicotine was subjected to a current of air at the rate of 30 liters per hour in an apparatus similar to the one used by Rudolfs. At the end of 3 hours and 6 hours nicotine contents of 2.74 per cent and 2.75 per cent, respectively, were found. This experiment was checked with another mixture containing 1.89 per cent nicotine. At the end of the test the nicotine content was found to equal that present in the dust originally.

It has been shown by Thatcher and Streeter and by others that carbonates release free nicotine from nicotine sulfate quite rapidly. A mixture was next used containing bentonite, 10 per cent calcium carbonate, and nicotine sulfate. This dust, after being subjected to a current of air for 4 hours, contained nicotine equal to the amount present at the time of mixing.

Samples of the first two preparations have been kept in glass-stoppered bottles for 8 months and after this period the loss of nicotine was less than 5 per cent of the total.

Summary

Bentonite has high adsorbing powers and should not be used as a carrier for nicotine where volatility is desired.

Rapid decomposition of nicotine from bentonite-nicotine sulfate mixtures does not take place as suggested.

Nicotine can be recovered from bentonite quantitatively by steam distillation.

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FUMIGATION WITH CALCIUM CYANIDE FOR THE CONTROL OF THE GREATER AND LESSER BULB FLIES

By F. R. COLE, *U. S. Bureau of Entomology, Santa Cruz, California*

During the past few years the growers of narcissus and daffodil bulbs have been making an attempt to clean up fly-infested stock, in accordance with the recommendations of the Federal Horticultural Board. The hot-water treatment, as developed in England and Holland, and vacuum fumigation with carbon disulphide have been used to kill bulb fly larvae in the bulbs in storage.

These methods destroy all of the fly larvae present, but apparently result at times in unsatisfactory flowering of the forced stock when the bulbs have been improperly handled before and after treatment.

Last year investigations were carried on at Santa Cruz, California, to determine the effect of box fumigation with calcium cyanide on larvae and pupae of bulb flies in storage. The first test was made in the fall of 1926 by C. F. Doucette. These first experiments, although not 100 per cent successful, indicated that this method might be developed and perfected. Subsequent experiments conducted by the writer were encouraging; in fact, at the recommended dosage the mortality was 100 per cent and there was no apparent injury to the foliage or to the flowering of field-grown and forced stock.

Much of the success of fumigation with calcium cyanide depends on the equipment and the manner in which it is used. The fumigation box must be very well made so that it will be airtight, particular care being required in fitting the door, as any gas leakage may so weaken the concentration as to allow fly larvae to recover.

Although the bulbs can be fumigated in any airtight box, one of 100 cubic feet capacity is convenient, as a box of this size can be readily loaded and the dosage easily calculated. In tests made to date the bulbs have been spread in shallow trays to insure immediate penetration of the gas. In a box of 100 cubic feet capacity about 10,000 bulbs of average size can be treated at one time. If the crop cannot be treated fast enough at this rate, a second box, or several units of this size, can be constructed.

The calcium cyanide best adapted for this type of fumigation is in the form of a finely ground powder from which the gas evolves slowly. A cyanide of this type, intended especially for use in greenhouses, is now manufactured commercially. Unless atmospheric humidity is very low no additional moisture is required in the box; an excess of moisture may absorb or break down the gas. The temperature should range

between 60 and 90 degrees F. The recommended dosage for 100 cubic feet is 12 ounces and the recommended exposure, 4 hours. This is an extremely heavy dosage, but the fly larvae, particularly when buried in bulb tissue, are very resistant to the gas. Fortunately the bulbs can stand a much heavier dosage of gas with no ill effects than can the insects.

The large and apparently tough larvae of *Merodon* are more easily killed by the fumigation than the small larvae of *Eumerus*. There may be some slight movement of larvae for a short time after the box is opened, but at the recommended dosage no recovery has been observed. The pupae of *Eumerus*, although rarely met with at the regular time of fumigation, neverthless have to be considered, and they are much harder to kill than the larvae. Under normal conditions of development there are no pupae of *Merodon* at digging or harvest time.

In all probability the treatment of infested bulbs with hydrocyanic-acid gas evolved from calcium cyanide will prove to be a very efficient method of killing the fly larvae. About 2,000 *Eumerus* larvae and more than 350 *Merodon* larvae were counted in the various tests and none survived the treatment.

The only questions still unanswered regarding the effect on the insects of fumigation of bulbs with calcium cyanide are the following:* (1) Are all the eggs of *Eumerus* destroyed by the treatment? (At the time the bulbs would ordinarily be fumigated there would be no eggs of *Merodon*.) (2) Can all the first-stage larvae of *Merodon* which are buried in fresh, gummy tissue be killed with certainty? Experiments now under way should settle these points.

ISOLATION OF CERTAIN YEAST FORMS FROM *EUTETTIX TENELLUS* BAKER

By WALTER CARTER, *Associate Entomologist, U. S. Dept. of Agriculture*, and F. B. COTNER, *Associate Professor, Montana State College*

ABSTRACT

The importance of the internal condition of the insects in connection with insect-borne diseases of plants is stressed, and attention is called to two yeast forms found in culture solutions after the feeding of *Eutettix tenellus* Baker. One of these is here described by F. B. Cotner as *Torula tenellicola* n. sp. The other is *Monilia nigra* Browne. The effect of these two yeasts on the optical rotation of sugars is shown in a table.

*These two points have been settled successfully by experiments conducted during 1928. Low tmperatures have been the only obstacles in obtaining perfect kills in all stages.

The attention of entomologists has been called by some recent publications to the possible significance of the internal condition of the plant as a factor in insect control (*4*), (*6*).[1] This internal condition of the plant is probably of far greater significance in connection with insect-borne plant diseases than it is with the insects directly attacking the plant.

On the other hand, the internal condition of the insect, especially in connection with such insect-borne diseases as curly-top of sugar beets, is a subject of inquiry deserving of more attention than it has thus far received.

One of the writers (*2*), (*3*), has described a technic for feeding homopterous insects on artificial culture solutions. This method offers an approach to the problem of the internal condition of the insect, at least in so far as the feeding of the insect affords an insight into its flora and fauna.

Heavy growths of yeasts in the culture solutions often resulted from the feeding of *Eutettix tenellus* Baker on solutions of sucrose, dextrose, and other sugars. In the case of one species of yeast the culture contents of the membranous sac sometimes became pink from the accumulation of yeast cells.

Since the examination of check cultures gave negative results, the finding of yeasts in the solutions after the insects had fed upon them clearly indicated that the yeast cells had passed through the mouth parts into the solutions.

The preliminary culturing of the two yeasts identified and the study of their effect on the optical rotation of sugars were done at the Twin Falls laboratory of the Bureau of Entomology, Twin Falls, Idaho, but their isolation and identification were made by F. B. Cotner of Montana State College.

Attempts were also made to obtain these organisms from beets, but in the experience of both authors no isolation could be made from beets on which no leafhoppers had fed. From beets which had been fed upon, both organisms have been recovered. Both organisms have also been obtained from both infective and noninfective leafhoppers.

The first of the isolations studied proved to be a pink Torula, the characteristics of which do not conform to any of the descriptions in the available literature and, moreover, this insect is a distinctly new host for this group of yeasts. For these reasons the writers consider this fungus to be sufficiently distinct to be given a new specific name.

[1]Reference is made to publications shown in the list of literature cited.

Since, in the course of the studies, this organism has not been isolated from other species of leafhoppers, the name *Torula tenellicola* n. sp. is proposed. The description[2] follows.

Torula tenellicola n. sp.

Agar colonies, light coral red (7), circular, slightly convex, smooth, becoming slightly rugose with age, with regular even margin becoming minutely lobed.

Liquid cultures, no acid or gas formed with dextrose, lactose, maltose, or sucrose, with decomposition of sucrose. Pink sediment and ring are formed.

Morphology: Vegetative cells oval to elliptical 5–6 by 3–4 microns, with one or two fat globules. Reproduction by budding. No ascospores formed.

The second, or black fungus, studied from isolations from *Eutettix tenellus* Baker, was identified as *Monilia nigra* Browne.

All of the fungus studies were made with cultures from single cell isolation.[3]

It will be observed from the data in Table 1 that singly these two yeasts materially change the optical rotation of sucrose. In combination this effect is apparently inhibited. The same is true when bacteria are mixed with *Torula tenellicola* Cotner.

The secretion of enzymes results from the presence of these organisms. According to Lindner (5) and Buchner (1) yeast cells have been noted in the blood of insects. A few pertinent questions present themselves: What is the effect of these organisms on the insects and on the plant, especially if the latter is a sugar-producing plant? Are they digested by the insect? Do they secrete enzymes in the blood stream of the insect? If so, with what effect?

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(2) CARTER, W. 1927. A technic for use with homopterous vectors of plant disease with special reference to the sugar-beet leafhopper, *Eutettix tenellus* Baker. Jour. Agr. Research, 34:449–451, illus.

(3) ————. 1928. An improvement in the technique for feeding homopterous insects. Phytopathology, 18:246–247.

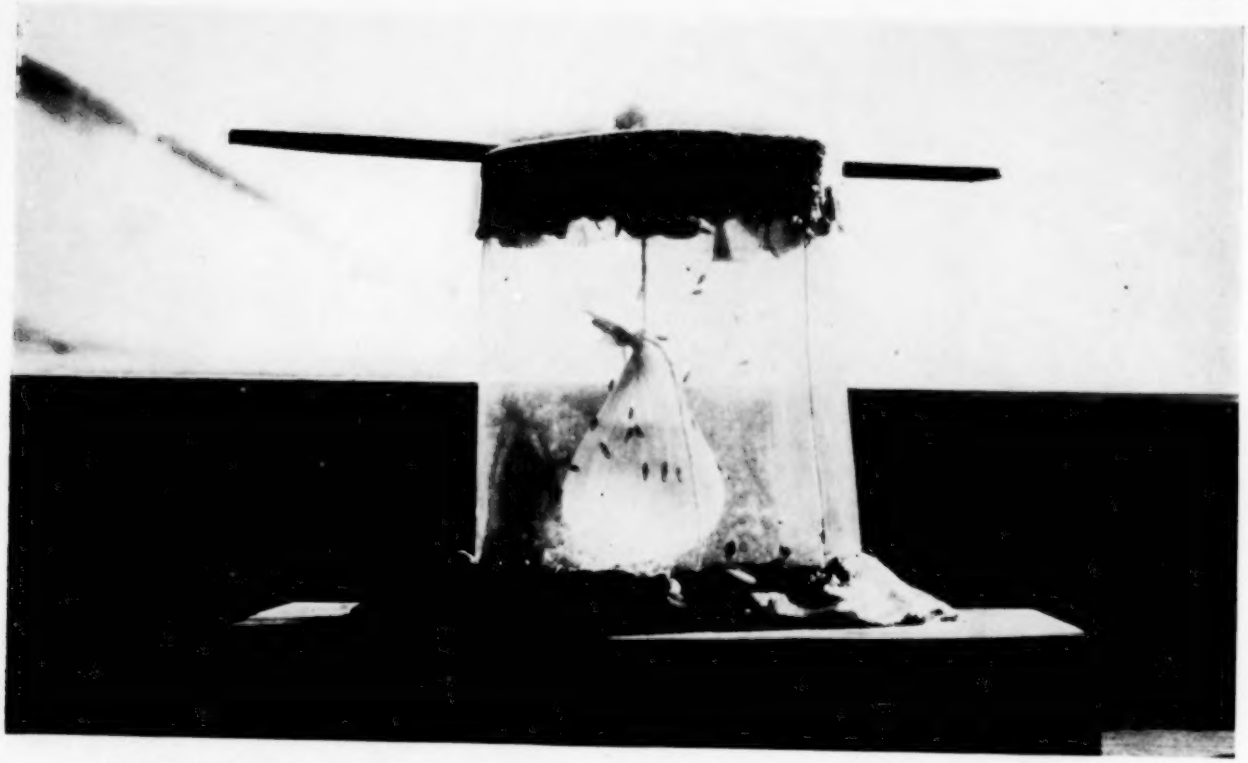
[2]Description by F. B. Cotner.

[3]These single spore isolations were made by the usual method of progressive dilution of suspensions of the yeasts until platings on Petri dish cultures showed only one or two well isolated colonies on each plate. These were then picked out and the process repeated.

TABLE 1. EFFECT OF MONILIA NIGRA AND TORULA TENELLICOLA ON THE OPTICAL ROTATION OF SUGAR[1]

Date	2 Per cent Dextrose	5 Per cent Dextrose	5 Per cent Sucrose	1 Per cent Maltose	5 Per cent Maltose	5 Per cent Galactose	2 Per cent Xylose	5 Per cent Xylose	1 Per cent Arabinose	5 Per cent Dextrin
				Monilia nigra						
1926										
Dec. 13	—	8.20	10.30	—	—	—	—	—	—	—
Dec. 21	—	8.20	3.50	—	—	—	—	—	—	—
				Torula tenellicola						
Nov. 20	2.70	—	9.70	3.60	—	—	1.30	—	3.00	—
Nov. 24	2.80	—	9.20	3.60	—	—	1.20	—	3.00	—
Nov. 29	—	—	5.20	—	—	—	—	—	—	—
			Monilia nigra plus *Torula tenellicola* Growing in Sterile Beet Juice							
Dec. 31	—	19.0	9.4	—	7.4	11.5	—	2.7	—	23.8
1927										
Jan. 6	—	19.4	9.5	—	7.8	11.7	—	2.8	—	19.2
				Torula tenellicola plus Bacterial Contamination						
1926										
Dec. 23	—	9.8	10.1	—	25.9	14.5	—	—	—	—
Dec. 29	—	9.8	9.3	—	24.2	15.5	—	—	—	—
				Duplicate of the Last Experiment						
Dec. 31	—	7.6	9.6	—	19.0	12.1	—	—	—	—
1927										
Jan. 6	—	7.8	9.4	—	19.1	12.0	—	—	—	—

[1]These data were obtained by the use of a Bausch & Lomb polariscope with Jellet polarizer calibrated to read sugar degrees based on standard weight of 26 grams of pure sucrose in 100 c.c. of water at 20°C. Polariscope tubes of 20 millimeter length were used. In each case one platinum loopful of the organism was used. The sugars were added to sterile water in sterile tubes, and 50 per cent of each lot was taken as an untreated check. In no case was any change in polariscope reading observed in the checks.



Eutettix tenellus feeding on sucrose solution. Cage is made of automobile celluloid with muslin on top

(4) LEES, A. H. 1926. Insect attack and the internal condition of the plant. Ann. Apl. Biol., 13:506–515.

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TWO INTRODUCED ANTS NOT PREVIOUSLY KNOWN TO OCCUR IN THE UNITED STATES[1]

By M. R. SMITH, *A. & M. College, Mississippi*

During the past year or so I have noted two species of imported ants which, although now established in this country have not heretofore been recorded. One of the ants to which I refer is a *Myrmicine* ant, the other a *Dolichoderine* ant. The latter, *Iridomyrmex iniquus* Mayr., is of especial interest as it belongs to the same genus as that of the very destructive imported Argentine ant. I first noted this ant in the floral greenhouse at the University of Illinois in 1925. Here the workers were found crawling over the benches and such plants as orchids, palms, etc. They were particularly noted to attend the soft brown scale, *Coccus hesperidum* Linn. on citrus, the hemispherical scale, *Saissetia hemisphaericum* (Targ.) on palm, and the mealy bug, *Pseudococcus citri* (Risso) on citrus. A number of workers were seen assiduously attending the mealy bugs mentioned above, from which they had secured so much honey dew that their abdomens were greatly distended. Besides honey dew, the ants also feed on the flesh of organisms. In several instances, workers were noted carrying in their mouths small midges (Chironomids).

The nests of this ant were never conspicuous and were located only after considerable search. In every case observed they were found in either the soil of pots or in the soil on the floor of the greenhouse rooms. I would have expected this ant to be present in large numbers, but such was not the case. In my opinion the ants were not abundant enough to cause any special alarm.

A greenhouse attendant stated that he believed the ants had been present in the greenhouse since 1914, and were most probably introduced with orchids from Brazil. If he is right in this assumption, then

[1]Contribution from the Mississippi Agricultural Experiment Station.

this ant cannot develop rapidly enough under greenhouse conditions to be considered a serious pest.

Iridomyrmex iniquus was described by Mayr in 1870 from specimens taken at Colombia, South America. The synonymy of the species is as follows:

I. iniquus Mayr. Sitz. Akad. Wiss. Wien, Vol. 71, p. 392 (1870), worker (*Hypoclinea iniqua*).

Hypoclinea (*I.*) *iniqua* Mayr. Verh. Zool.-bot. Ges. Wien, Vol. 20, p. 958 (1870) worker.

Iridomyrmex iniquus Forel, *ibidem*, Vol. 58, p. 395, (1908) male.

At the present time there are four distinct forms of *Iridomyrmex* known to occur in the United States. Beside the two imported forms here mentioned, there are the two native ants, *I. pruinosus* (Roger), and its variety *analis* André. It is hoped that the following key will suffice for the determination of the workers of the typical forms of these species:

1. Head distinctly sub-triangular.....2
   Head not sub-triangular, but sub-rectangular; workers when crushed give off a perceptible nauseating or sweetish "Tapinoma" odor.....3
2. Mesonotum with a transverse impression; a deep constriction or suture before the epinotum, thus causing the latter to appear very gibbose; a small (2.2 mm.) shining, imported species.....*I. iniquus* Mayr.
   Mesonotum without a transverse impression; epinotum not gibbose; larger (2.2–2.6 mm.) more pubescent or subopaque imported species; workers when crushed give off a perceptible greasy or musty odor.....*I. humilis* Mayr.
3. Head, thorax and abdomen almost a uniform brown, pubescence of such a nature as to give the body in some lights a pruinose or frosty appearance..... *I. pruinosus* (Roger).
   Head and thorax brown, abdomen pale yellowish, thus giving the body a bi-colored appearance.....*I. pruinosus* var. *analis* André.

The second species of ant, *Wasmannia auropunctata* (Roger) was received from a correspondent, Mr. R. H. Hickman, who stated that the ants were taken on the property of a wealthy man living in the vicinity of Miami, Fla. He also mentioned the fact that the ants would sting viciously, but did not remark whether they were noted to infest houses or not.

At a superficial glance at the worker of this species under the binoculars, one would be inclined to regard this minute species as a form of *Tetramorium*, and in fact it has been placed by some of the older systematists in this group. From *Tetramorium* the genus *Wasmannia* can be separated by the worker and female possessing an antennal scrobe which is bordered laterally by a more or less distinct carina of the cheeks.

The following is the synonymy of the species:

W. auropunctata (Roger), Berl. Ent. Zeitschr. Vol. 7, p. 182 (1863) male, female, worker (*Tetramorium?*).

Tetramorium auropunctatum Forel, Bull. Soc. Vaud. Sc. Nat. Vol. 20, p. 375 (1884); Mayr, Verh. Zool.-bot. Ges. Wien, Vol. 37, p. 623 (1887).

Ochetomyrmex auropunctatus Forel, Ann. Soc. Ent. Belg. Vol. 30, C. R. p. 49 (1886).

Tetramorium (Xiphomyrmex) auropunctatum Forel, Mitt. Schweiz. Ent. Ges. Vol. 7, p. 385 (1887).

Wasmannia auropunctata Forel, Trans. Ent. Soc. Lond. p. 383 (1893) worker, male, female; Wheeler, Bull. Amer. Mus. Nat. Hist. Vol. 24, p. 143, pl. 12, f. 18 (1908) worker.

LEAFHOPPERS (*HOMOPTERA, CICADELLIDAE*) FOUND ON THE SUGAR BEET IN IOWA[1]

By R. M. Jones

During the summer of 1928, beginning August 1, a survey was made of the insect pests feeding on the sugar beet in Iowa. The main object of this survey was to determine if the Sugar Beet Leafhopper (*Eutettix tenella* Baker) and "curly-top," the disease which it transmits, occurred in this state. Although six weeks were spent scouting in the fields neither the leafhopper or the disease was found.

During this work the author became interested in collecting all species of leafhoppers present in the fields, and a special effort was made to do this in all cases. The collections were made in fields under contract to the American Beet Sugar Company, Mason City, Iowa. Six counties were scouted in the northern part of the state, namely: Cerro Gordo, Worth, Mitchel, Hancock, Winnebago and Kossuth.

The writer greatly appreciates the help of Dr. C. J. Drake, Iowa State College, for it was due to his efforts that this survey was possible; also the assistance of Dr. D. M. DeLong, Ohio State University, who determined the species. Thanks are also due Dr. H. H. Knight, Iowa State College, for suggestions; and to Mr. Baird, the manager of the American Beet Sugar Company, who kindly supplied a complete list of all their growers.

A review of the literature indicates that nine species of leafhoppers have been reported on the sugar beet. Osborn and Gossard (1891) reported *Agallia sanguinolenta* Prov. on sugar beets at Ames, Iowa, on the Experiment Station plots. Forbes and Hart (1900) also found this species on beets on the University farm, Urbana, Illinois. Ball (1909)

[1]Contribution from the Department of Zoology and Entomology, Iowa State College, Ames, Iowa.

and Maxson (1920) reported them in the sugar beet territories of Colorado and Utah.

Forbes and Hart (1900) reported *Agallia novella* Say on sugar beets in Iowa.

Forbes and Hart (1900) report *Deltocephalus inimicus* Say and *Cicadula sexnotata* Fall as being especially common on sugar beets on the University farm, Urbana, Illinois. They also found *Phlepsius irroratus* Say and *Typhlocyba* sp., but not in as large numbers as the first two named.

Ball (1909) reports several species of *Empoasca* on sugar beets in California, but no definite species was stated.

Ball (1909) and Maxson (1920) state that *Eutettix chenopodii* Osb. was rather common on beets in Colorado and Utah.

Forbes and Hart (1900) and Ball (1909) both report *Eutettix seminudus* Say on beets in Illinois.

Aside from the species listed above the writer found four additional species of leafhoppers that represent new records on sugar beets. *Cicadula variata* Fall and *Platymetopius cinereus* Osb. & Ball were very common in all the fields scouted. *Euscelis obscurinervis* Stal was fairly common in most localities, while *Xestocephalus superbus* Prov. was found to be rather uncommon as only a few specimens were taken.

The following is a list of the species of leafhoppers found by the writer on the sugar beet during 1928, with notes on distribution and abundance.

Agallia sanguinolenta Prov. August 1–September 15. Present in large numbers in all fields scouted.

Agallia novella Say. August 1–September 15. Not as common as *Agallia sanguinolenta* Prov. Only a few specimens being taken.

Deltocephalus inimicus Say. August 1–September 15. Very common. Found in all fields.

Cicadula sexnotata Fall. August 1–September 15. Very abundant.

Cicadula variata Fall. August 1–September 15. Numerous in all fields.

Empoasca fabae Walsh. August 1–September 15. Probably most abundant of all species collected.

Eutettix seminudus Say. August 1–September 15. Rather common over entire sugar beet territory scouted.

Eutettix chenopodii Osb. August 1–September 15. Only a few specimens were taken. Rather uniformly distributed in all fields observed.

Phlepsius irroratus Say. Only four specimens were taken. One near Britt, Hancock County, August 18; one near Rake, Winnebago County, September 3; and the other two near Ledyard, Kossuth County, September 6–7. Not common.

Xestocephalus superbus Prov. August 1–September 15. Not very common. Only a few scattered specimens were taken.

Typhlocyba sp. One specimen taken August 23, at Corwith, Hancock County.

Platymetopius cinereus Osb. & Ball. August 1–September 15. Very common. Found in almost every field scouted.

Euscelis obscurinervis Stal. August 1–September 15. Not found in large numbers. Present in every county scouted.

Literature Cited

Ball, E. D. 1909. The leafhoppers of the sugar beet and their relation to the curly-top condition. U. S. Bur. Ent. Bull. 66, pp. 50–53.

Forbes, S. A., and Hart, C. A. 1900. The Economic Entomology of the Sugar Beet. Ill. Agri. Exp. Sta. Bull. 60, pp. 417–425.

Maxson, A. C. 1920. Principal Insect Enemies of the sugar beet in the territories served by the Great Western Sugar Company, pp. 126–128.

Osborn, H., and Gossard, H. A. 1891. Some insect enemies of the sugar beet. Iowa Agri. Exp. Sta. Bull. 15, pp. 270.

THE PRODUCTION AND DISTRIBUTION OF TRICHOGRAMMA

By Stanley E. Flanders, *Riverside, Calif.*

Over ten years ago Mokrzecki and Bragina stated that "theoretically an unlimited number of *Trichogramma* may be reared in the laboratory." This conclusion was reached after several years of experimentation and implies that the economical mass production of this minute chalcid is only limited by inadequate rearing media and equipment since the vital factors are adaptable.

Recently entomologists in Europe and Japan have been utilizing the eggs of *Ephestia kuehniella* reared on various grains for boosting *Trichogramma* populations for experimental purposes. The quantity produced was limited and hopelessly inadequate to accomplish economic results.

In the fall of 1926 while testing a number of species of moths for use as laboratory hosts the writer discovered that *Sitotroga cerealella* was peculiarly adapted for the purpose. Because its habits and tropisms proved to be adaptable to mechanical manipulation the writer was able to solve the problem of mass production.

The widespread interest in *Trichogramma* production and in the method used resulted in inquiries from Australia and Ceylon as well as from every quarter of the United States. A typical inquiry is as follows:

Mr. S. E. Flanders,
Saticoy, California.

Dear Mr. Flanders:

Mr. J. E. Graf has just been in our office and has told us something of the work you are doing in breeding *Trichogramma minutum pretiosa* in enormous numbers for work in walnut codling moth control.

We are very much interested in your methods and technique in this work as we are desirous of attempting to breed *Trichogramma* early this spring for tests in connection with our sugarcane borer control work. Last season we found the Trichogrammas breeding abundantly in *Heliothis* and certain *Protoparce* eggs early in the season but no infestation on cane borer eggs until the end of August. We would like to try colonizing the *Trichogramma* in early borer-infested corn or cane to see if it may not be possible thus to check their multiplication very much earlier in the season than it occurred last year.

Mr. Graf stated that he was sure you would be glad to give us very full information regarding your methods and experience in this work.

We shall greatly appreciate it, therefore, if you will write us fully regarding your breeding room arrangements, your temperature control devices, the host species on which you get your parasites to develop most readily, your methods of holding the parasites in the host eggs until you are ready to place them in the fields, the temperature at which this is possible, etc., etc.

We believe that we can make arrangements here without much delay to breed moths from infested corn. I would be glad to know the range of host species that you have found commonly parasitized there and particularly whether bean weevil eggs are parasitized as an abundance of such eggs could be secured very readily here.

We thank you for any information and illustrations that you may be able to send us to assist us in this work.

Very sincerely yours,

W. E. HINDS,
Entomologist.

The equipment needed for the daily production of a million *Trichogramma* consists of an insectary of three rooms as follows:

	Sq. ft. of floor space	Air temp.	Relative humidity
Moth rearing room	500	60 to 75 F	approx. 60%
Trix rearing room	100	75 to 85 F	approx. 60%
Storage room	100	35 to 45 F	approx. 60%

moth-egg production units with a total capacity of ten tons of common white corn, parasitizing equipment as follows:

1 26-mesh wire strainer
1 18-mesh wire strainer
1 roll of pliable glazed cardboard
12 dozen cardboard mailing cans (3½x5in.)
1 80-mesh copper screen pan
1 gallon of shellac
1 16-mesh wire strainer, 6 in. diam.
2 glass one-gallon jars, 6x8 in.
50 ft. plate glass, 4 in. to 5 in. wide
6 dozen rolls of fine wire
1 pair shears
several bristle brushes,

and additional equipment of

1 electric hair dryer
5 ft. of 1¼ in. hose
1 suction cap for glass jar
10 pounds putty
6 desk fans
4 20-mesh copper screen pans
2 dozen selected glass petri dishes.

The labor of one man two or three hours a day is necessary to maintain production.

The production units vary from simple open trays to deep bins in which transverse tilted partitions provide for the egress of the newly emerged moths.

The moths are either collected by suction and placed in cylindrical egg-deposition cages capped on each end with 20-mesh screens or are forced to emerge from the bins directly into adjacent egg-deposition cages. In either case egg deposition is stimulated by a forced draft of air against the outer surface of the 20-mesh screen.

A sheet iron unit holding 1600 pounds of corn is now being tested for egg production. The dead and weak moths are removed by means of a suction hose inserted along the lower edge of the egg deposition screen and the eggs by opening a trap door beneath. This type of unit can be constructed for less than $200.

The moths are then placed in a separate cage for 24 hours after which they are poured into a wire strainer and rinsed under a strong stream of water to remove adhering eggs. The eggs settle to the bottom and the debris rises to the surface and is drained off. The eggs are then separated out by pouring through an 80-mesh screen and dried in a current of air. Thousands of eggs are conserved in this manner.

The daily procedure in parasite production is as follows:

Every 24 hours the eggs are collected from the moth-egg units, screened and winnowed of moth scales and appendages and fastened to sheets of pliable cardboard with shellac. Before the shellac dries the loose eggs are shaken off or washed off under water.

The sheets of cardboard are of sufficient size to carry on one side about 150,000 eggs or 6 eggs to each square millimeter.

Each sheet is fitted snugly to the inside surface of the parasitizing container which is a cardboard can or mailing tube having a metal cap and bottom. When the egg-card is in position a section of a parasitized egg-card from which parasites have commenced to emerge is inserted and the container then inverted on a plate glass shelf. After a period of 24 hours with ventral illumination the emergence card is removed and placed in a container of fresh eggs. The containers are left on the glass shelves for 48 hours and are then set aside until ready to use. Each emergence card is usable for two batches of eggs.

Neon and mercury vapor lamps are now being tested as a source of illumination. These are tubes 24 inches long and are fastened to the ventral surface of the glass shelves.

The size of the emergence card used for stinging a fresh egg-card depends on the number of Trix needed to obtain a 90 per cent parasi-

tism. This may vary from one-third to one-fifth of the size of the card to be stung. A six to ten fold reproduction may thus be obtained from each emergence card.

The procedure in liberation of the Trix in the field is as follows:

The egg-cards are placed in the field just as emergence begins. The cards are cut into sections of 10,000 eggs and a fine wire several inches in length is attached to each section.

Each section is suspended from the lower portion of the food plant of the host. An egg-card suspended by the fine wire is protected to a greater degree from attack by predators than when in contact with the plant.

Under normal conditions emergence is completed in from three to six days. The parasites remaining on the card at the end of this time are usually males. Since the males also tend to emerge prior to the females mating is insured.

The rate of dispersion from point of liberation varies directly with the temperature and light intensity and inversely with excessive air movement and surface moisture.

It is estimated that a section of 10,000 parasitized eggs is sufficient to cover at least 100 square yards of leaf surface of crop to be protected.

Trix appears to find its host by means of random movements.

PARASITES OF SUGAR CANE MOTH BORERS[1]

By D. L. Van Dine

Abstract

This is a review of our knowledge of the sugar cane moth stalk borer, *Diatraea saccharalis* Fabr., parasites in Cuba and of the available records of those found in other countries. The parasites are listed by countries and by species. There is also a bibliography.

The sugar cane moth stalkborer, *Diatraea saccharalis* Fabr., is an insect pest of major importance in Cuba. It is responsible for serious losses in both field and factory. In the field it not only affects growth and consequent tonnage, but it also shortens the life of a field, that is, the number of years that a cane field will continue to give ratoon crops without replanting. The lower sucrose of borer-infested cane reduces the amount of sugar in the cane, and, because of low purities, reduces

[1]Scientific Contributions No. 13, Tropical Plant Research Foundation. From the Cuba Sugar Club Experiment Station, Central Baraguá, Cuba. Presented at the Fourth International Congress of Entomology, held at Cornell University, Ithaca, New York, August 12–18, 1928.

also the factory yield, or the amount of sugar recovered from total sugar in the cane. The factory not only produces less sugar per ton of cane ground, but the cost of fabrication is also increased by reason of the poorer juices.

We recognize, in Cuba, that parasitic enemies exercise an important natural control of the moth borer in our cane fields. Investigations are being carried on by the Baraguá station to obtain a better understanding of the parasites of this insect which occur locally, their distribution in the cane areas, the environmental factors which appear to influence their abundance or limit their activity, their seasonal occurrence, and their comparative efficiency in the repression of the moth borer. This work is preliminary to explorational and introduction work. We hope to obtain parasites of moth borers from other cane regions and to utilize them to supplement those which we find in our fields.

In this preliminary work we feel that it is necessary to know the species that already occur in Cuba. We do not want to lose valuable time in the collection, transportation, and release of parasites, only to discover later that we already have them or to be misled by finding them and considering that we have recovered an introduced species. The error would be as great to introduce under another name a species which we have already, as to fail to recognize a species in our fields through lack of initial survey. In this phase of the work we are at an entire loss without the help of the systematist. In no branch of applied entomology is there greater need of definite identifications than in the utilization of parasites for the control of injurious insects. There can be no progress in entomology, in the use of parasites or otherwise, without the fundamental work of the specialists. So we must study our local parasites and survey the records of their distribution elsewhere, as well as the distribution and possible value for our conditions of those species which we do not find in Cuba.

This report is a review of our knowledge of the moth borer parasites in Cuba and of the available records of those found in other countries. Our interest in the subject is international. We hope that mutual interests in those countries where sugar cane moth borers are a problem will lead to close cooperation in control by the use of parasites.

Our work in Cuba will include an effort to determine the measures, if any, whereby the effectiveness of the local parasites may be extended or their efficiency increased. We refer to the influence of plantation operations and to methods of artificial propagation. The suggestion made by Holloway in Louisiana and by Wolcott in Porto Rico that the

burning of cane trash in cane fields reduces the numbers of the common egg-parasite, *Trichogramma minutum* Riley, may be cited as an example of one of these measures. Since this efficient egg-parasite occurs also in Cuba, we should consider this suggestion carefully. Another line of work worthy of attention is that being done in the artificial rearing of *Trichogramma minutum* by Flanders in California and by Hinds and Spencer in Louisiana. They are breeding in large numbers this parasite in the eggs of one of the grain moths which readily lends itself to this method of propagation. In Louisiana the idea is to breed the parasites during the winter months and early spring in order that many thousands can be released in the cane fields at the time when the moth borer becomes active, so that the parasites begin their beneficial control earlier than they would normally if their increase depended entirely upon their natural seasonal development.

In St. Vincent, one of the islands of the British West Indies, Harland reported in 1915 the results of studies on this same egg-parasite. He bred the parasite from the eggs of a number of moths and suggested that its efficiency could be increased against the moth borer of sugar cane by increasing the number of other hosts of *Trichogramma* in the neighborhood of cane fields, being cautious that neither the alternate host nor its plant host are prejudicial to agricultural crops. He found that a moth, *Utetheisa ornatrix* Linn., feeding upon a legume of the genus *Crotalaria*, appeared to fill the requirements in St. Vincent. We planted some Sun Hemp (*Crotalaria juncea*) at the Baraguá Station and found it was attacked by a moth which has been identified for us by Dr. W. Schaus of the U. S. National Museum as *Utethesia venusta* Dalman. The *Crotalaria* is a beneficial plant, one that will not escape cultivation and become a weed in the cane fields, and the moth which we have found feeding upon it in Cuba does not appear to feed upon other field crops. This will be an interesting line of work to continue.

Certain insects, the larvae of which are parasitic upon other insects, have distinct food habits as adults. They may possibly feed upon the flowers of plants. For them to become established in a region it is therefore essential that their plant host, as well as their insect host, be present. It is important to consider these food plants of the adult parasite along with the insect hosts, when introductions are made from one region to another. It is possible that the distribution of a parasite within a region may be influenced by this factor.

Parasites of the moth borer of sugar cane have been taken from Cuba to Louisiana and to Florida in the United States and to Mexico. The

Central American parasites of the moth borer have been transported to Porto Rico and to some of the islands of the British West Indies. Formosa successfully introduced an egg-parasite of their moth borer from Java. The U. S. Bureau of Entomology is sending an explorer to Argentina to bring out their moth borer parasites for Louisiana. The Philippines are sending a man to Java for moth borer parasites. Hawaii has explorational work under way in New Guinea for parasites of the weevil cane borer, and I understand that Mr. Pemberton will keep in mind also the possibility of moth borer parasites for Louisiana. This is all work of great promise in which the Cuba sugar cane planters wish to join.

There are many ways in which cooperation in explorational work can be made profitable. Such cooperation would include an exchange of information on the areas that have been surveyed, the parasites that have been found, the results from importing them from one region to another, the conditions that appear to count for success or failure, the time required, and the methods used. Even joint collections or shipments might be carried on where the requirements of two countries happen to coincide. The International Society of Sugar Cane Technologists has a special standing committee on "Exploration for Parasites of Sugar Cane Insects" under the chairmanship of Mr. A. H. Rosenfeld of New Orleans, Louisiana. Perhaps this Congress could unite by some means with this work on exploration for parasites of sugar cane insects to consider the work along this line for all insects.

While the writer favors cooperation in all efforts on explorational work for parasites, it is not considered that joint support and direction of such work is practical. When a serious attempt is made to utilize the parasites found in one country for the needs of another, careful collections and studies must be made in the country to be benefited and in the region to be explored, with the special requirements particularly in mind. I consider that divided interests would lessen the effectiveness of the work. The foreign work requires great personal responsibility on the part of the explorer, and having been given such responsibility, he should also be given full authority and support for such individual effort. He should not be limited by conflicting interests, either in time, or in too much long-distance direction. Each region should assume its share of the work, directed to meet its own requirements, and by real cooperation profit by the work of all.

There is presented a list of the cane moth borer parasites which are known to occur in Cuba, together with the parasites of sugar cane moth

borers in other countries. The numbers in parenthesis, after the names of authorities, refer to the list of references at the end of the report.

PARASITES OF *Diatraea* AND OTHER MOTH BORERS
(Arranged by countries)

CUBA

Species of moth borers: *Diatraea saccharalis* Fabricius
Diatraea lineolata Walker
Elasmopalpus lignosellus Zeller

PARASITES:

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Cardin, 1915 (17); Wolcott, 1915 (69): Holloway & Loftin, 1919 (33); Holloway, 1919 (34); Salt, 1926 (56); Van Dine, 1926 (64) Van Dine, 1926 (65); Holloway, Haley, & Loftin, 1928 (40).

Sarcophaga helicis Townsend. Sarcophagid. Parasite of larva.
Bred from larva of *Diatraea saccharalis* Fabr., collected by H. K. Plank, July 24, 1926, at Central Jaronú, Province of Camagüey, Cuba. Determined by J. M. Aldrich of the U. S. National Museum.

Lixophaga diatraeae Townsend. Tachinid. Parasite of larva.
References: Cardin, 1915 (17), records a Tachinid parasite of the larva (undetermined); Wolcott, 1915 (69), recorded a Tachinid fly as *Tachinophyto* (*Hypostena*) sp.; Holloway & Loftin, 1919 (33); Holloway, 1919 (34); Holloway & Loftin, 1919 (35); Van Zwaluwenburg, 1923 (66); Holloway, 1923 (36); Holloway, 1924 (37); Wolcott, 1924 (73); Van Zwaluwenburg, 1926 (67); Salt, 1926 (56); Van Dine, 1926 (64); Van Dine, 1926 (65); Box, 1926 (9); Holloway, 1927 (39); Box, 1927 (10); Plank, 1927 (52); Holloway, Haley, & Loftin, 1928 (40); Holloway, 1928 (41).

Apanteles diatraeae Muesebeck. Braconid. Parasite of larva.
References: Holloway, 1919 (34), recorded as Apanteles sp.; Muesebeck, 1920 (49); Van Zwaluwenburg, 1926 (67); Salt, 1926 (56); Van Dine, 1926 (64); Van Dine, 1926 (65); Box, 1926 (9); Holloway, Haley, & Loftin, 1928 (40).

(*Microdus*) *Bassus diatraeae* (Turner). Braconid. Parasite of larva.
Bred from larvae of *Diatraea saccharalis* Fabr., collected by B. T. Barreto, January 16 and March 26, 1926, and by H. K. Plank, June 14, June 20, and November 11, 1926, at Central Jaronú, Province of Camagüey, Cuba. Determined by R. A. Cushman of the U. S. National Museum.

(*Microdus*) *Bassus stigmaterus* (Cresson). Braconid. Parasite of larva.
References: Cresson, 1865 (20); Gundlach, 1886 (27); Holloway, 1919 (34); Salt, 1926 (56); Van Dine, 1926 (64); Van Dine, 1926 (65); Plank, 1927 (52); Holloway, Haley, & Loftin, 1928 (40); Box, 1928 (14).

(*Microdus*) *Bassus* sp. (Undetermined) Braconid. Parasite of larva.
References: Box, 1926 (9); Box, 1927 (10).

Microgaster sp. Braconid. Parasite of larva.
Recorded by Cardin, 1915 (17), as a parasite of the larva of *Diatraea lineolata* Walker, in corn; Van Dine, 1926 (65).

Cordyceps barberi Giard. Fungous parasite of larva and pupa.

References: Cardin, 1915 (17); Johnston, 1917 (47); Salt, 1926 (56); Van Dine, 1926 (64); Van Dine, 1926 (65); Plank, 1927 (52).

Sarcophaga sternodontis Townsend. Sarcophagid. Parasite of pupa.

References: Van Zwaluwenburg, 1923 (66); Van Zwaluwenburg, 1926 (67); Salt, 1926 (56); Van Dine, 1926 (64); Van Dine, 1926 (65); Box, 1926 (9); Plank, 1927 (52); Holloway, Haley, & Loftin, 1928 (40).

UNITED STATES

Species of moth borers: *Diatraea saccharalis* Fabricius, in sugar cane, rice and corn, Gulf Coast.

Diatraea zeacolella Dyar, in corn, northern Florida, Georgia, North and South Carolina, and Virginia.

Chilo loftini Dyar, in sugar cane and Johnson grass, Arizona.

Meropleon cosmion Dyar, in sugar cane and corn, Mississippi.

Diatraea grandiosella Dyar, in corn, Arizona, Texas, New Mexico.

Chilo plejadellus Zincken, in rice, Louisiana.

PARASITES

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.

References: Holloway, 1913 (32); Bodkin, 1913 (2); Holloway & Loftin, 1919 (33); Holloway, 1919 (34); Holloway & Loftin, 1919 (35); Box, 1926 (9); Holloway & Haley, 1927 (38); Holloway, 1927 (39); Ingram, 1927 (43); Holloway, Haley, & Loftin, 1928 (40); Holloway, 1928 (41); Wolcott, 1924 (73); Salt, 1926 (56); Hinds & Spencer, 1928 (29); Hinds & Spencer, 1928 (30); Flanders, 1928 (25); Hinds, 1928 (31).

Ufens niger (Ashmead). Trichogrammid. Bred from eggs of *Diatraea saccharalis* Fabr., Texas

References: Holloway & Loftin 1919 (33); Holoway & Loftin, 1919 (35); Salt, 1926 (56); Box, 1926 (9); Holloway, Haley, & Loftin, 1928 (40).

Microceromasia sphenophori Villeneuve. Tachinid. A parasite of the sugar-cane weevil stalkborer, *Rhabdocnemis obscurus* Boisduval, introduced and successfully established in Hawaii from New Guinea. Introduced for trial against *Diatraea saccharalis* Fabr. from Hawaii to Louisiana in 1917 with negative results.

References: Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40); Holloway, 1928 (41).

Lixophaga diatraeae Townsend. Tachinid. Parasite of larva and pupa. Introduced from Cuba. The parasites were released on 41 plantations during 1919 and 1920 and since that time have been recovered on 25 plantations.

References: Holloway & Loftin, 1919 (33); Holloway, 1919 (34); Holloway & Loftin, 1919 (35); Holloway, 1923 (36); Holloway, 1924 (37); Wolcott, 1924 (73); Box, 1926 (9); Holloway, 1927 (39); Holloway, Haley, & Loftin, 1928 (40); Holloway, 1928 (41).

Habrobracon brevicornis (Wesmael). Braconid. Parasite introduced from France to the United States for use in control of the European corn borer, *Pyrausta nubilalis* Hübner, and sent from Massachusetts to Louisiana for trial against the cane borer, *Diatraea saccharalis* Fabr. Parasitism was successful in cages under laboratory conditions but negative results were obtained under field conditions.

References: Van Zwaluwenburg, 1926 (67); Holloway, 1928 (39); Holloway, Haley, & Loftin, 1928 (40); Holloway, 1928 (41).

Microbracon sp. Undescribed. Braconid. Parasite of larvae of *Diatraea saccharalis* Fabr. and *Chilo plejadellus* Zincken in rice, Louisiana.

References: Ingram, 1927 (43); Holloway, Haley, & Loftin, 1928 (40).

Microgaster harnedi Muesebeck. Braconid. Parasite bred from larvae of *Pyrausta ainslei* Heinrich, Mississippi, and of *Diatraea* sp., South Carolina.

References: Muesebeck, 1922 (50); Salt, 1926 (56).

Microgaster sp. Braconid. Bred from larva of *Diatraea zeacolella* Dyar in corn, South Carolina.

References: Holloway & Loftin, 1919 (33); Box, 1926 (9).

Cordyceps barberi Giard. Fungous parasite of larva and pupa. Introduced from St. Croix with negative results.

References: Holloway, Haley, & Loftin, 1928 (40).

Sarcophaga sternodontis Townsend. Sarcophagid. Parasite of pupa. Introduced from Cuba.

References: Box, 1926 (9); Van Zwaluwenburg, 1926 (67).

JAMAICA

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Lixophaga diatraeae Townsend. Tachinid. Parasite of larva and pupa.

References: Wolcott, 1924 (73).

PORTO RICO

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Prophanurus alecto Crawford. (*Telenomus* sp. of some writers). Scelionid. Parasite of egg.

References: Wolcott, 1922 (70); Wolcott, 1923 (71); Wolcott, 1924 (72); Box, 1924 (7); Box, 1928 (9); Box, 1928 (13); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.

References: Van Dine, 1911 (61); Bodkin, 1913 (2); Van Dine, 1913 (62); Van Dine 1913 (63); Jones, 1915 (48); Holloway & Loftin, 1919 (33); Wolcott, 1923 (71); Box, 1924 (7); Wolcott, 1924 (72); Wolcott, 1924 (73); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

(*Microdus*) *Bassus diatraeae* (Turner). Braconid. Parasite of larva. Introduced from British Guiana.

References: Box, 1926 (9); Box, 1928 (14).

Ipobracon grenadensis (Ashmead). (*Iphiaulax medianus* Cameron). Braconid. External parasite of larva. Introduced from Venezuela and British Guiana.

References: Box, 1924 (7); Box, 1926 (9); Box, 1927 (10); Catoni, 1927 (18); Box, 1928 (14).

Lixophaga diatraeae Townsend. (*Tachinophyto* (*Hypostena*) sp.). Tachinid. Parasite of larva and pupa.

References: Van Dine, 1913 (62); Van Dine, 1913 (63); Jones, 1915 (48); Wolcott, 1915 (69); Holloway & Loftin, 1919 (33); Wolcott, 1923 (71); Box, 1924 (7); Wolcott, 1924 (73); Box, 1926 (9); Salt, 1926 (56); Box, 1927 (10); Holloway, Haley, & Loftin, 1928 (40); Box, 1928 (14).

Cordyceps barberi Giard. Fungous parasite of larva and pupa.

References: Van Dine, 1911 (61); Van Dine, 1913 (62); Van Dine, 1913 (63); Jones, 1915 (48); Johnston, 1917 (47); Holloway & Loftin, 1919 (33); Wolcott, 1923 (71); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

ST. CROIX

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Cordyceps barberi Giard. Fungous parasite of larva and pupa.

References: Holloway, Haley, & Loftin, 1928 (40).

ANTIGUA

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Ipobracon granadensis (Ashmead). (*Iphiaulax medianus* Cramer). Braconid. External parasite of larva. Introduced from British Guiana via Trinidad.

Rererences: Box, 1928 (14).

BARBADOS

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Prophanurus alecto Crawford. (*Telenomus* sp. of some writers.) Scelionid. Parasite of egg.

References: Bourne, 1923 (6); Box, 1926 (9).

Trichogramma minutum (pretiosa) Riley. Trichogrammid. Parasite of egg.

References: Ballou, 1912 (1); Holloway & Loftin, 1919 (33); Bourne, 1923 (6); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

(*Microdus*) *Bassus diatraeae* (Turner). Braconid. Parasite of larva. Introduced from British Guiana.

References: Skeete, 1925 (57).

(*Microdus*) *Bassus* sp. Barconid. Parasite of larva. Introduced from British Guiana.

References: Skeete, 1925 (57).

Ipogracon grenadensis (Ashmead). (*Iphiaulax medianus* Cameron). Braconid. External parasite of larva. Introduced from British Guiana.

References: Bourne, 1923 (6); Skeete, 1925 (57); Box, 1928 (14).

Ipobracon puberulus (Szépligeti). Braconid. Parasite of larva. Introduced from British Guiana.

References: Skeete, 1925 (57).

(*Iphiaulax*) *Ipobracon* sp. Braconid. Parasite of larva. Introduced from British Guiana.

References: Bourne, 1923 (6).

Cordyceps barberi Giard. Fungous parasite of larva and pupa.

References: Johnston, 1917 (47).

ST. VINCENT

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Prophanurus alecto Crawford. Scelionid. Parasite of egg.
References: Harland, 1915 (28).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Harland, 1915 (28).

GRENADA

Species of moth borers: *Diatraea saccharalis* Fabricius
Diatraea canella Hampson

PARASITES:

Ipobracon grenadensis (Ashmead). (*Iphiaulax medianus* Cameron). Braconid. External parasite of larva.
References: Box, 1928 (14).

TRINIDAD

Species of moth borers: *Diatraea saccharalis* Fabricus
Diatraea canella Hampson
Diatraea lineolata Walker

PARASITES:

Prophanurus alecto Crawford. (*Telenomus* sp. of some writers). Scelionid. Parasite of egg.
References: Box, 1926 (9).

Prophanurus sp. Scelionid. Parasite of egg.
References: Urich, 1915 (59); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Urich, 1915 (59); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Oxysarcodexia peltata Aldrich.[1] ("According to C. H. T. Townsend, probably this species".—See Holloway, Haley, & Loftin, 1928 (40)). Tachinid. Parasite of larva.
References: Urich, 1915 (59); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Cyanopterus sp. Braconid. Parasites of larva.
References: Urich, 1915 (59); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Ipobracon grenadensis (Ashmead). (*Iphiaulax medianus* Cameron). Braconid. External parasite of larva. Introduced from British Guiana.
References: Box, 1926 (9); Box, 1926 (14).

Metarrhizium anisopliae Metsch. Green Muscardine fungus attacking larva.
References: Urich, 1915 (59); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

VENEZUELA

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Prophanurus alecto Crawford. Scelionid. Parasite of egg.
References: Box, 1928 (13).

[1]According to Dr. J. M. Aldrich this is almost certainly a scavenger.

Ipobracon grenadensis (Ashmead). (*Iphiaulax medianus* Cramer). Braconid. External parasite of larva.

References: Box, 1927 (10); Catoni, 1927 (18); Box, 1928 (14).

BRITISH GUIANA (DEMERARA)

Species of moth borers: *Diatraea saccharalis* Fabricius
Diatraea canella Hampson
Diatraea lineolata Walker

PARASITES:

Prophanurus (*Phanurus*) *alecto* Crawford. (*Telenomus* sp. of some writers.) Scelionid. Parasite of egg.

References: Wolcott, 1913 (68); Bodkin, 1914 (5); Cleare, 1923 (19); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40); Box, 1928 (13).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.

References: Bodkin, 1913 (3); Bodkin, 1913 (4); Wolcott, 1913 (68); Holloway & Loftin, 1919 (33); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Geosargus (*Sargus*) sp. Stratiomyid. Parasite of larva(?).

Rerefences: Bodkin, 1914 (5); Salt, 1926 (56).

Leskiopalpus flavipennis Wiedemann. Tachinid. (Determined as this species by C. H. T. Townsend.) (Determined by Imperial Bureau of Entomology as *Stomatodexia* sp., very near *S. diadema* Wied., family Dexiidae.) Parasite of larva.

References: Cleare, 1923 (19); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Lixophaga diatraeae Townsend. Trachinid. Parasite of larva and pupa. Introduced from Porto Rico.

References: Bodkin, 1913 (3), records a Tachinid fly "unknown", which C. H. T. Townsend thinks is probably this species; Holloway & Loftin, 1919 (33); Box, 1924 (7); Box, 1926 (9).

Tachinid fly. Undetermined. Parasite of larva(?)

References: Wolcott, 1913 (68).

(*Microdus*) *Bassus diatraeae* (Turner). Braconid. Parasite of larva.

References: Turner, 1918 (58); Skeete, 1925 (57); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40); Box, 1928 (14).

(*Microdus*) (*Cremnops*) *Bassus parvifaciatus* (Cameron). Braconid. Parasite of larva.

References: Bodkin, 1913 (3); Holloway & Loftin, 1919, (33); Cleare, 1923 (19); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

(*Microdus*) (*Cremnops*) *Bassus* sp. Undetermined. Braconid. Parasite of larva.

References: Bodkin, 1913 (3); Holloway & Loftin, 1919 (33); Skeete, 1925 (57) Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Ipobracon grenadensis (Ashmead). (*Iphiaulax medianus* Cramer). Braconid. External parasite of larva.

References: Bodkin, 1913 (3); Wolcott, 1913 (68); Turner, 1918 (58); Holloway & Loftin, 1919 (33); Bourne, 1923 (6); Cleare, 1923 (19); Box, 1924 (7); Skeete, 1925 (57); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Box, 1927 (10); Holloway, Haley, & Loftin, 1928 (40); Box, 1928 (14).

Ipobracon puberulus (Szépligeti). Braconid. Parasite of larva.
References: Skeete, 1925 (57); Box, 1926 (8); Box, 1926 (9); Holloway, Haley, & Loftin, 1928 (40).

Ipobracon saccharalis Turner. Braconid. Parasite of larva.
References: Turner, 1918 (58); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Ipobracon spp. (*Iphiaulax* spp.) Braconids. Parasites of larva. Undetermined.
References: Bodkin, 1913 (3); Wolcott, 1913 (68); Holloway & Loftin, 1919 (33); Bourne, 1923 (6); Cleare, 1923 (19); Box, 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Mesostenoideus spp. Undetermined. Ichneumonid. Parasite of larva.
References: Bodkin, 1913 (3); Holloway & Loftin, 1919 (33); Cleare, 1923 (19); Box. 1926 (8); Box, 1926 (9); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Cordyceps barberi Giard. Fungous parasite of larva and pupa.
References: Bodkin, 1913 (3); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Heptasmicra curvilineata Cameron. Chalcid. Parasite of pupa.
References: Bodkin, 1913 (3); Holloway & Loftin, 1919 (33); Cleare, 1923 (19); Box, 1926 (8); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

DUTCH GUIANA

Species of moth borers: *Diatraea saccharalis* Fabricius
Diatraea canella Hampson
Diatraea lineolata Walker

PARASITES:

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Box, 1926 (9).

ARGENTINA

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Prophanurus n. sp. Undescribed. Scelionid. Parasite of egg.
References: Box, 1927 (11); Cross, 1928 (21); Box, 1928 (13); Box, 1928 (12).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Rosenfeld & Barber, 1914 (54); Bréthes, 1927 (15); Box, 1927 (11); Cross, 1928 (21); Box, 1928 (13); Box, 1928 (12).

Sarcophaga diatraeae[1] Bréthes. Sarcophagid. Parasite of larva.
References: Bréthes, 1927 (15), states that this parasite is attacked in Argentina by a hyperparasite, *Aulatopria tucumana* n. sp.; Cross, 1928 (21).

"Dexiid". Undetermined. Parasite of larva.

[1]According to Dr. J. M. Aldrich this is a synonym of *Paratheresia signifera* Townsend.

References: Cross, 1928 (21).

Oxysarcodexia peltata Aldrich. "According to C. H. T. Townsend, probably this species."—See Holloway, Haley, & Loftin, 1928 (40). Tachinid. Parasite of larva.

References: Rosenfeld & Barber, 1914 (54); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Paratheresia signifera Townsend. Tachinid. Parasite of larva(?)

References: Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Box, 1927 (10).

(*Microdus*) *Bassus crossi* (Bréthes). Braconid. Parasite of larva.

References: Bréthes, 1927 (15); Cross, 1928 (21).

(*Microdus*) *Bassus* sp. Undetermined. Braconid. Parasite of larva.

References: Rosenfeld & Barber, 1914 (54); Holloway & Loftin. 1919 (33); Box, 1926 (9); Holloway, Haley, & Loftin, 1928 (40).

Hemibracon sp. Undetermined. Braconid. Parasite of larva(?)

References: Bréthes, 1927 (15).

Ipobracon tucumanus (Bréthes). Braconid. Parasite of larva.

References: Bréthes (15); Cross, 1928 (21).

"Intestinal Worm." Undetermined. Parasite of larva.

References: Rosenfeld & Barber, 1914 (54); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

PERU

Species of moth borers: *Diatraea saccharalis* Fabricius

PARASITES:

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.

References: Rosenfeld, 1926 (55).

"Muscoid Parasite". Undetermined. Parasite of larva(?)

References: Rosenfeld, 1926 (55).

Paratheresia signifera Townsend. Tachinid. Parasite of larva (?).

References: Van Zwaluwenburg, 1926 (67).

Hemibracon sp. Undetermined. Braconid. Parasite of larva (?)

References: Rosenfeld, 1926 (55).

MEXICO

Species of moth borers: *Diatraea saccharalis* Fabricius, in cane, corn, and grasses.
Diatraea magnifactella Dyar, in cane.
Diatraea lineolata Walker, in cane and corn.
Diatraea grandiosella Dyar, in corn.
Chilo loftini Dyar, in cane and rice.
Chilo morbidellus Dyar, in cane.

PARASITES:

Chelonus sonorensis[2] Cameron. Braconid. Parasite of egg.

References: Van Zwaluwenburg, 1926 (67).

(*Pentarthron*) *Trichogramma fasciatum* (Perkins). Trichogrammid. Parasite of egg.

References: Perkins, 1912 (51); Girault, 1913 (26); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.

References: Van Zwaluwenburg, 1926 (67); Salt, 1926 (56).

Phorostoma sp. Undetermined. Dexiid. Parasite of larva(?)

[2]According to Dr. A. B. Gahan this is really a larval parasite.

References: Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Holloway, Haley, & Loftin, 1928 (40).

Lixophaga diatraeae Townsend. Tachinid. Parasite of larva and pupa. Introduced from Cuba.

References: Van Zwaluwenburg, 1923 (66); Wolcott, 1924 (73); Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Holloway, Haley, & Loftin, 1928 (40).

Paratheresia signifera Townsend. Tachinid. Parasite of larva (?)

References: Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Holloway, Haley, & Loftin, 1928 (40).

Apanteles diatraeae Muesebeck. Braconid. Parasite of larva.

References: Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Holloway, Haley, & Loftin, 1928 (40).

Habrobracon brevicornis (Wesmael). Braconid. Parasite of European corn borer, *Pyrausta nubilalis* Hübner, introduced from Louisiana for trial against larvae of *Diatraea* and *Chilo*.

References: Van Zwaluwenburg, 1926 (67).

Mesostenus sp. Undetermined. Ichneumonid. Parasite of larva (?)

References: Van Zwaluwenburg, 1926 (67).

Sarcophaga sternodontis Townsend. Sarcophagid. Parasite of pupa. Introduced from Cuba.

References: Van Zwaluwenburg, 1923 (66); Box, 1926 (9); Van Zwaluwenburg, 1926 (67); Holloway, Haley, & Loftin, 1928 (40).

FORMOSA

Species of moth borers: *Diatraea striatalis* Snellen
Chilo infuscatellus Snellen
Scirpophaga auriflua Zeller

PARASITES:

Phanurus beneficiens (Zehntner). Scelionid. Parasite of egg. Introduced from Java.

References: Ishida, 1927 (45).

Phanurus beneficiens var. *elongatus* Ishida. Scelionid. Parasite of egg of *Scirpophaga auriflua*. Introduced from Java.

References: Ishida, 1927 (45).

Diatraeophaga striatalis Townsend. Tachinid. Parasite of larva. Introduced from Java.

References: Ishida, 1927 (45).

JAVA

Species of moth borers: *Diatraea striatalis* Snellen
Chilo infuscatellus Snellen
Scirpophaga auriflua Zeller
Grapholitha schistaceana Snellen

PARASITES:

Phanurus beneficiens (Zehntner). Scelionid. Parasite of egg.

References: Van der Goot, 1915 (60); Ishida, 1915 (44); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Ishida, 1927 (45); Holloway, Haley, & Loftin, 1928 (40).

Phanurus beneficiens var. *elongatus* Ishida. Scelionid. Parasite of eggs of *Scirpophaga auriflua*.
References: Ishida, 1927 (45).

Phanurus sp. Undetermined. Parasite of egg.
References: Ishida, 1915 (44).

Trichogramma minutum (*pretiosa*) Riley. Trichogrammid. Parasite of egg.
References: Van der Goot, 1915 (60); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma australicum Girault. Trichogrammid. Parasite of egg.
References: Van der Goot, 1915 (60); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma nanum (*nana*) Zehntner. Trichogrammid. Parasite of egg.
References: Van der Goot, 1915 (60); Ishida, 1915 (44); Holloway & Loftin, 1919 (33); Salt, 1926 (56); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma pseudonana Ishida. Trichogrammid. Parasite of egg.
References: Ishida, 1915 (44).

Diatraeophaga striatalis Townsend. Tachinid. Parasite of larva.
References: Van der Goot, 1915 (60); Holloway & Loftin, 1919 (33); Ishida, 1927 (45); Holloway, Haley, & Loftin, 1928 (40).

Braconid. Undetermined. Parasite of larva.
References: Van der Goot, 1915 (60); Holloway, Haley, & Loftin, 1928 (40).

MAURITIUS

Species of moth borers: *Diatraea* sp.

PARASITES:

Telenomus sp. (probably *Prophanurus alecto* Crawford). Scelionid. Parasite of egg.
References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Trichogramma australicum Girault. Trichogrammid. Parasite of egg.
References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Tachinid fly. Undetermined. Parasite of larva(?)
References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

Apanteles simplicis Viereck. Braconid. Parasite of larva (?)
References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

(*Ophion*) *Henicospilus antancarus* (*antakarus*) (Saussure). Ichneumonid. Parasite of larva(?)
References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

(*Ophion*) *Stauropodoctonus mauritii* (Saussure). Ichneumonid. Parasite of larva(?)

References: Emmerez de Charmoy, 1895 (23); Emmerez de Charmoy, 1917 (24); Holloway & Loftin, 1919 (33); Holloway, Haley, & Loftin, 1928 (40).

RUSSIA

Species of moth borers: *Diatraea* sp.

Parasites:

(*Pentarthron*) *Trichogramma fasciatum* (Perkins). Trichogrammid. Parasite of egg.

References: Girault, 1913 (26); Salt, 1926 (56).

TURKESTAN

Species of moth borers: *Diatraea* sp.

PARASITES:

(*Pentarthron*) *Trichogramma fasciatum* (Perkins). Trichogrammid. Parasite of egg.

References: Girault, 1913 (26); Salt, 1926 (56).

PARASITES OF *Diatraea* AND OTHER MOTH BORERS

(Arranged by Species)

PARASITES OF THE EGG

Hymenoptera

Braconidae

Chelonus sonorensis[1] Cameron. Mexico.

Scelionidae

Phanurus beneficiens (Zehntner). Formosa (introduced from Java), Java.

Phanurus beneficiens var. *elongatus* Ishida. Formosa (introduced from Java), Java.

Phanurus sp. Java.

Prophanurus (*Phanurus*) *alecto* Crawford. (*Telenomus* sp.) Porto Rico, Barbados, St. Vincent, Trinidad, Venezuela, British Guiana, Mauritius.

Prophanurus n. sp. Undescribed. Argentina.

Prophanurus sp. Trinidad.

Trichogrammidae

Trichogramma australicum Girault. Java, Mauritius.

(*Pentarthron*) *Trichogramma fasciatum* (Perkins), Mexico, Russia, Turkestan.

Trichogramma minutum (*pretiosa*) Riley. Cuba, United States, Porto Rico, Barbados, St. Vincent, Trinidad, British Guiana, Dutch Guiana, Argentina, Peru, Mexico, Java.

Trichogramma nanum (*nana*) Zehntner. Java.

Trichogramma pseudonana Zehntner. Java.

Ufens niger (Ashmead). United States.

PARASITES OF THE LARVA

Diptera

Stratiomyidae

Geosargus (*Sargus*) sp.(?)[2] British Guiana.

[1]loc cit.

Muscoidea

"Muscoid parasite." Undetermined. (?) Peru.

Sarcophagidae

Sarcophaga diatraeae[3] Bréthes. Argentina (attacked by hyperparasite, *Aulatopria tucumana* (Bréthes).

Sacophaga helicis Townsend. Cuba.

Dexiidae

Phorostoma sp. Undetermined. (?) Mexico.

"Dexiid fly." Undetermined. Argentina.

Tachinidae

Ceromasia sphenophori Villeneuve. United States (introduced from Hawaii with negative results).

Diatraeophaga striatalis Townsend. Formosa (introduced from Java), Java.

Leskiopalpus flavipennis Wiedemann. British Guiana.

Lixophaga diatraeae Townsend. Cuba, United States (introduced from Cuba), Jamaica, Porto Rico, British Guiana (introduced from Porto Rico), Mexico (introduced from Cuba).

Oxysarcodexia peltata[3] Aldrich. Trinidad, Argentina.

Parathresia signifera Townsend. (?) Argentina, Mexico, Peru.

"Tachinid flies". Undetermined. (?) British Guiana, Mauritius.

Hymenoptera

Braconidae

Apanteles diatraeae Muesebeck. Cuba, Mexico.

Apanteles simplicis Viereck. (?) Mauritius.

(*Microdus*) *Bassus crossi* (Bréthes). Argentina.

(*Microdus*) *Bassus diatraeae* (Turner). Cuba, Porto Rico (introduced from British Guiana), Barbados (introduced from British Guiana), British Guiana.

(*Microdus*) (*Cremnops*) *Bassus parvifasciatus* (Cameron). British Guiana.

(*Microdus*) *Bassus stigmaterus* (Cresson). Cuba.

(*Microdus*) (*Cremnops*) *Bassus* sp. Cuba, Barbados (introduced from British Guiana), British Guiana, Argentina.

Cyanopterus sp. Trinidad.

Habrobracon brevicornis (Wesmael). United States (introduced from France with negative results), Mexico (introduced from United States).

Hemibracon sp. (?) Argentina, Peru.

Ipobracon grenadensis (Ashmead). Porto Rico (introduced from British Guiana and Venezuela), Barbados (introduced from British Guiana), Antigua (introduced from British Guiana via Trinidad), Grenada, Trinidad (introduced from British Guiana), Venezuela, British Guiana.

Ipobracon puberulus (Szépligeti). Barbados (introduced from British Guiana), British Guiana.

Ipobracon saccharalis Turner. British Guiana.

Ipobracon tucumanus (Bréthes). Argentina.

Ipobracon spp. Undetermined. Barbados (introduced from British Guiana), British Guiana.

[2]Note (?) after a species indicates that there was no information in the references as to the parasitism of the larva or the pupa.

[3]loc cit.

Microbracon sp. Undescribed. United States.
Microgaster harnedi Muesebeck. United States.
Microgaster sp. Cuba, United States.
Braconid. Undetermined. Java.
Ichneumonidae
Mesostenoideus sp. British Guiana.
Mesostenus sp. (?) Mexico.
(*Ophion*) *Henicospilus antancarus* (*antakarus*) (Suassure). (?) Mauritius.
(*Ophion*) *Stauropodoctononus mauritii* (Suassure). (?) Mauritius.
"Intestinal worm". Undetermined. Argentina.
Entomogenous fungi
Cordyceps barberi Giard. Cuba, United States (introduced from St. Croix with negative results), Porto Rico, Barbados, St. Croix, British Guiana.
Metarrhizium anisopliae Metsch. (?) Trinidad.

PARASITES OF THE PUPA

Diptera
Sarcophagidae
Sarcophaga sternodontis Townsend. Cuba, United States (introduced from Cuba), Mexico (introduced from Cuba).
Tachinidae
Lixophaga diatraeae Townsend. (See under parasites of the larva).
Hymenoptera
Chalcididae
Heptasmicra curvilineata Cameron. British Guiana.
Entomogenous fungus
Cordyceps barberi Giard. (See under parasites of the larva).

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Scientific Notes

Persimmon as a Host of the Oriental Fruit Moth. During October, 1928, at Carbondale, Ill., two larvae, about one-third grown, of *Laspeyresia molesta* Busck, were placed on the fruit of wild persimmon. They entered, riddled the fruit, and left in two weeks, full grown, to spin their cocoons. This shows that it is possible for persimmon to act as a host for the later broods of the Oriental Fruit Moth, a fact which might prove of importance in such peach regions as the Ozark Hill section of southern Illinois, where persimmons abound in the woodlands adjoining many of the orchards.

S. C. CHANDLER, *Illinois State Natural History Survey*

The Purity of Commercial Orthodichlorobenzene. The effectiveness of paradichlorobenzene as an insecticide has led to the testing of the ortho isomer by a number of investigators, to whom the following portions of a letter from one of the manufacturers, received by the writer, may be of interest:

"The material shipped to you contains about 30% Para, 40% Ortho, and 30% Trichlorbenzene. This material and similar liquors are always called 'Orthodichlorobenzene' by the trade and are quoted under this name in the commercial journals."

"Since we had shipped this 'Orthodichlorobenzene' to others, we did not bring this matter to your attention. In other words, there is no pure orthodichlorobenzene (except that manufactured as a reagent and sold for several dollars a pound) and the mixture which we forwarded to you is what is called 'Orthodichlorobenzene'."

J. WILLIAM LIPP, *Moorestown, N. J.*

***Marasmia trapezalis* Guenée on Sugar-Cane only in Hispaniola and Peru of the Western Hemisphere.** In the note first reporting the attack of the larva of *Marasmia trapezalis* Guenée on sugar-cane in Haiti and Dominican Republic (Jour. Ec. Ent., Vol. 18, p. 422, April, 1925), attention was drawn to the absence of this insect in Cuba, Jamaica and Porto Rico. More recently, it is reported on the same host in Perú (Townsend, C. H. T., "Insectos que atacan al Algodón y a la Caña de Azucár en el Peru," Bol. No. 1, Estacion Experimental Agricola, Lima, Peru, May, 1928), and from Dr. Townsend's records, as well as from personal observation, the distribution in Peru is known to include practically all localities where cane is grown, not only along the coast, but also isolated trans-Andean districts. The determination of the Peruvian material is by Mr. August Busck, from material submitted by Mr. C. L. Royle, Chemist for Central "Cartavio" at Trujillo, where the insect is so abundant at times as to cause considerable damage to young cane. Indeed, the injury by the caterpillars is so obvious in so many parts of Peru that determination of its distribution in other parts of South America should be of interest. From personal observation, it is known not to be present in the cane fields of Venezuela, and on questioning Mr. Harold E. Box, whose experience includes British Guiana (Demerara), Venezuela and Argentina, his reply—"I have no experience at all with this pest"—indicates its absence in these countries. This leaves Ecuador, Colombia

and Brazil as possible localities where it may be present, but it has never been reported from any of these countries.

GEORGE N. WOLCOTT, *Entomologist,*
Estacion Experimental Agricola, Lima, Peru

Heleria rubidella **Ball Comparatively Unknown Membracid Becomes Abundant and Probably Injurious in Orchards in the Wenatchee, Wash., District.** During the season of 1928 great numbers of this membracid were observed on the twigs and smaller branches of apple trees in the alfalfa-cover-cropped orchards in the Wenatchee, Wash. district. The insect was first noticed in 1926, when a six acre orchard at the outskirts of Wenatchee was taken over for the season by the Washington Experiment Station for a series of spraying experiments. It was present along with the several other species of treehoppers, which were known to be injurious to fruit trees in Pacific Northwest orchards.[1] It was not known, however, by those first noticing it that it was a new record for the species. When this was learned it was too late to make observations or collections. Mr. Van Duzee, who determined the species, stated that this was the first reported occurrence in the West (west of Colorado). It was originally described in 1928 by Ball from Colorado (Proc. Biol. Soc. Wash., XXXI:28).

This seems to be an instance where an insect has escaped the attention of entomologists for several years after its description, when all at once, apparently, it becomes of considerable economic importance. So far as known the insect has not been observed outside of the Wenatchee Valley in Washington.

M. A. YOTHERS, R. L. WEBSTER and ANTHONY SPULER

A New Pest of English Walnuts in California. The Trypetid, *Rhagoletis juglandis* Cresson, was definitely identified this season from Chino, California, where it was found infesting the English walnut (*Juglans regia*). The species has probably been present in several groves in that area for two or three years or more. The extent of the infestation now includes an area of over twenty-five square miles.

The common name of Western Walnut Husk Maggot is proposed to distinguish this species from the Walnut Husk Maggot, *Rhagoletis suavis* Loew.

The flies began to emerge from the soil during the latter part of July and were present on the trees up until late September. Oviposition begins usually within ten to twenty days after emergence. The eggs are deposited in batches of from fifteen to twenty-five in the green husks of the walnuts. The late varieties that have a relatively thick husk are in general most severely attacked, the apparent reason being due to the fact that the husk is more readily penetrated by the ovipositor of the female. The eggs hatch in from four to seven days and the larvae tunnel within the husk. As a result of larval feeding a soft decay of the husk develops and the shell of the nut is permanently stained. Affected nuts cannot be successfully bleached and must consequently be disposed of as "off grades." A great preference is shown for the Eureka variety of which fully 90 per cent were attacked in some orchards this year, of these not all however, were sufficiently injured to interfere with their sale to best advantage.

[1]Yothers, M. A. Treehoppers, New Orchard Pests in the Pacific Northwest. *In* Proc. Wash. State Hort. Assoc. R. 20, pp. 97–102.

The larvae on reaching maturity leave the nuts and go into the ground to a depth of from two to twelve inches where pupation takes place. The indications are that an appreciable percentage of the brood will require two years to complete the life cycle.

Larvae of two other species of flies, namely, *Euxesta notata* Weid. and *Lonchaea occidentalis* Malloch were found feeding in the husks of those walnuts that were already injured by *R. juglandis* or by mechanical agencies.

On the basis of this season's preliminary control experiments it appears that spraying with basic arsenate of lead offers a satisfactory method of combating this pest.

A. M. BOYCE, *Univ. of Calif. Citrus Exp. Station, Riverside, Calif.*

Note on the Occurrence of the Dusky-Veined Walnut Aphis, *Callipterus juglandis* Frisch (an European insect) in America. The dusky-veined walnut aphis,[1] *Callipterus juglandis* Frisch, not heretofore recorded as occurring in the United States, was found to be doing damage to walnuts in the central Willamette valley last summer (1928). Between 2,000 and 3,000 acres of walnuts were affected. The infestation centered around Dundee and the sections north of McMinnville.

This aphis is much larger than the ordinary walnut aphis, *Chromaphis juglandicola* Kalt. Unlike the ordinary walnut aphis, it works entirely on the upper surface of the leaves. As many as 50 aphids were found on a leaf, located in a double row along the mid-rib and facing the stem end. The mid-ribs of the infested leaves were blackened and shrivelled. The leaves had a sickly appearance and were blotched with yellow.

The first control measures were applied on July 20, 1928, and on this date the wingless forms were the most numerous, but few winged forms being observed. A two per cent nicotine dust thoroughly applied between midnight and 8:00 A.M. gave excellent control. This treatment was applied by most of the growers in the infested area. Dust applied during the day was ineffective due to windy conditions.

B. G. THOMPSON, *Assistant Entomologist, Oregon Experiment Station, Corvallis, Ore.*

[1]Determined by Dr. P. W. Mason of the U. S. Bureau of Entomology.

Collecting Vial for Small Insects. In the August number of the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 21, No. 4, pp. 632–633, 1928) appeared an article, with illustrations, by Milton F. Crowell, entitled "A vial for catching small leaping insects." I have used a type similar to the one illustrated, either using a paper cone or a wire screen cone. I have found them far from satisfactory due to the cone either dropping out or slipping far down the vial at the most crucial time of capturing a much desired specimen. At the suggestion of Dr. E. Martini of the Institut für Schiffs- und Tropenkrankheiten, Hamburg, Germany, I have had made a much simpler collecting vial. This consists of glass tubing, one inch in diameter and about five inches long, with one end blown within the tube in the form of a cone. The glass cone takes the place of the wire netting and the opening at the apex of the cone may be made any size desired. Figure 45 a (this JOURNAL Vol. 21, p. 632) illustrates my collecting vial, the glass cone replacing the wire cone and a cork closing the opposite end of the vial. This gives an excellent collecting vial as a number of insects may be taken without any danger of them escaping. Furthermore the captured specimens

may be transferred to a large bottle by the removal of the cork. In this way a large series may be taken in the field with only one collecting vial. I had these collecting vials made for me by the glassblower employed by the Department of Chemistry, Cornell University. It requires about five minutes to make a single vial.

ROBERT MATHESON, *Dept. Entomology, Cornell University*

***Cryptolaemus montrouzieri* Mulsant, and its Allies.** The place of origin of this important beetle may be a little doubtful. It was said to come from Moreton Bay, Queensland, and I presume this is correct. But Montrouzier, after whom it is named, was the famous naturalist of New Caledonia, and it is included in Heller's list (1916) of the Coleoptera of New Caledonia. I myself found it in Noumea, New Caledonia, June 8, 1928. It was on a bean plant (*Phaseolus*) infested by *Pseudococcus virgatus* Ckll. and grey aphids. I found *P. virgatus* widely distributed in the island, as far north as Muéo (where it occurred on *Acalypha* and *Codiacum*), but nowhere abundant. It is probably controlled by the *Cryptolaemus*. *C. montrouzieri* does of course occur in Queensland (I have seen it from Kuranda, collected by Timberlake), but it is not likely to be native in both countries, so it may have originally come from either. Blackburn (1889) described a species, *C. simplex*, only known from Australia.

Chapuis in 1876 gave a long description of the genus *Cryptolaemus*, and Essig (1910) fully described *C. montrouzieri* in its various stages, with excellent figures.

Crotch in his work on the Coccinellidae (1874) recognized four species of *Cryptolaemus*. From the particulars he gives, I constructed the following table:

Elytra with a violet tinge; thorax with only anterior angles and front (narrowly) testaceous. Macassar (Wallace)..... *subviolaceus* Crotch.
Elytra with no violet tinge.....1
1. Thorax without posterior black patch or spot..... *montrouzieri* Mulsant.
Thorax with a more or less distinct posterior patch or spot of black.....2
2. Punctures of elytra very fine and rather obsolete. Gilolo (Wallace)..... *wallacii* Crotch
Punctures of elytra tolerably close, unequal.....3
3. Thorax with black spot at base hardly visible; apex of elytra broadly ochreous. Batchian (Wallace)..... *affinis* Crotch.
Thorax with a broad black spot, covering one-third of base; elytra narrowly edged with ochreous at apex. Dorey (Wallace)..... *affinis* Crotch, var. (probably a distinct species.)

Weise (1902) described *C. concinnus* from New Guinea.

In the collection of the Sugar Planters' Station in Honolulu, I found an interesting series of *Cryptolaemus*, as follows:

Prothorax black in posterior middle; red at apices of elytra reduced; rather large species. Laloki, Papua (Muir)...probably identical with *affinis* var. from Dorey.
Prothorax all red.....1
1. Only anterior legs red..... *montrouzieri* Mulsant.
All the legs red; small form. Larat (Muir) and Amboina (Muir)...new species?

T. D. A. COCKERELL, *University of Colorado, Boulder, Colorado.*

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ANNUAL SCIENTIFIC MEETINGS: 1929–30, Des Moines; 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

The late appearance of this issue is due in large measure to manuscripts not being placed in the hands of the editor promptly.

Those who take the trouble to look over the list of officers and members will note that we now have three branches, each regional in scope and three sections separated because of special interests. The branches should all prove important factors in building up membership in their respective territories and the constantly increasing membership indicates that this is the case. The branch meetings afford excellent opportunities for the presentation of papers of more less sectional interest and in this way they may very materially aid in reducing the program congestion of the annual meetings. The sections, with their topical restrictions, make possible the presentation of more papers at the annual meetings and afford an opportunity for discussion impossible if there was but one session. It is certain that all the time available can be used to advantage. The impossibility of every one listening to all the papers in which he is interested is now well recognized. The next best is early and if possible full publication of the proceedings not only of the annual meetings (including the sections) but also of the branches. We have not yet attained the ideal and it may be some time before this is possible. An organization of a thousand having a definite purpose can accomplish much. Our Association is a growing one and we may all look forward to still further progress. The limit of possibilities is far from being reached.

Reviews

Destructive and Useful Insects, Their Habits and Control by C. L. METCALF and W. P. FLINT, pages I–XII, 1–918, 561 text figures. McGraw-Hill Book Company, Inc., New York, 1928.

This is a most comprehensive, well-written, practical or economic Entomology which will be found especially valuable in the Mississippi and Ohio valleys, and of great service in the eastern part of the United States. The scope of the work is indicated by the chapters devoted to the injurious and beneficial insects, the external structure of insects, the internal anatomy and physiology of the group, the mouth parts of insects, development and metamorphosis, the place of insects in the animal kingdom, the orders of insects, insect control, insecticidal apparatus, and a series of chapters discussing the enemies of crops, crop products and animals as follows: corn, small grain and forage grasses, legumes, cotton, tobacco, vegetable gardens and truck crops, deciduous fruits and bush fruits, citrus insects, shade trees and shrubs, greenhouse insects, stored grains, seeds and cereal products, domestic animals and insects that attack man and affect his health. The volume is primarily economic and practical and the technical phases, such as the structure and physiology, are reduced to a minimum. The authors have made a special feature of a series of tables, synopses and outlines designed to give the essentials in a brief compass and these are of great value to the practical man wishing information in regard to the selection and application of insecticides or aid in the identification of insects attacking various crops. The large series of excellent illustrations, many of which have appeared in various bulletins and other publications, add greatly to the value of the work.

The reviewer notes the absence of any mention of forest insects, possibly necessitated by the fact that the volume already approaches practical limits so far as size is concerned and in apple and shade tree insects, regrets the omission of the introduced apple and thorn skeletonizer, now a serious pest in western New York and destined to spread to other sections of the country and among shade tree insects, the omission of the generally injurious spruce gall aphid, of the introduced willow leaf beetle and the European birch leaf miner. There are probably other species which might have been mentioned to advantage though the authors have shown excellent judgment in the selection of material and are to be highly commended in the production of such a generally useful work.

E. P. FELT

Locusts and Grasshoppers, a Handbook for Their Study and Control, by B. P. UVAROV, Page 1–252, 9 plates. The Imperial Bureau of Entomology, London, 1928.

This volume presents a general survey of our knowledge of locusts and grasshoppers, their bionomics and the theory and practice of control. It is practically the same as the original edition published at Moscow in Russian in 1927 by the Central Cotton Committee, with additional matter in relation to spermatophore fertilization, a discussion of parasites and their enemies known from all countries (only Palaeartic species being recorded in the Russian edition). There is also some information on mechanical methods little used in Russia and the chapter on the organization of control has been completely re-written. The final chapters designated as a

special part have been specially written and discuss the following species and topics: Moroccan locust, *Dociostaurus maroccanus* Thunbg., the migratory locust, *Locusta migratoria* L., the desert locust, *Schistocerca gregaria* Forsk., the South American locust, *Schistocerca paranensis* Burm., the brown locust, *Locustana pardalina* Wlk., the red locust, *Nomadacris septemfasciata* Serv., the Italian locust, *Calliptamus italicus* L., the solitary grasshoppers and the grasshopper problem in Siberia and North America and the locust and grasshopper problem in Australia, and the miscellaneous grasshopper species that swarm occasionally.

We have in this volume a comprehensive discussion of the destructive grasshoppers or locusts of the world, especially of those species which have been destructive in South Africa and the Old World. There is an extended bibliography and an excellent Index.

This work is particularly valuable because of its comprehensive character even though there appears to be relatively little consideration given to the North American work upon these insects.

E. P. FELT

Elementary Lessons on Insects by JAMES G. NEEDHAM, pages I–VIII, 1–210, 72 text illustrations. Charles C. Thomas, Springfield, Illinois, 1928.

This is, as indicated by its title, an elementary work or an outline for a brief introductory course in Entomology by a teacher qualified by years of experience. The subject matter is presented in a simple attractive manner, the text being illustrated by a series of typical figures. The author has succeeded admirably in selecting material which is easily available and of general interest, either on account of prevalence or economic importance. The technical phases of Entomology have been kept in the background and yet accuracy is not sacrificed in the elementary treatment. There is a tabulation of clues for recognition of the commoner orders of insects and a very concise guide to the insect enemies of principal crops for one who desires to work along that line. The final chapters on methods of collecting, mounting and rearing insects are most excellent.

E. P. FELT

Common Garden Pests, What They Are and How to Control Them by C. T. GREGORY and J. J. DAVIS, pages 1–15, published by Better Homes and Gardens, Des Moines, Iowa. 1928.

This is a concise, popular, well illustrated account of fungi and insects, their development and methods of control. There are chapters devoted to enemies of garden flowers, lawns, ornamental trees and shrubs and vegetables, the different trees and shrubs being arranged in alphabetical order. There are brief diagnostic or descriptive accounts of the various insects and fungi attacking the different plants together with recommendations for control. An appendix gives the essentials in relation to both fungicides and insecticides. This work with its numerous illustrations will prove very serviceable to all gardeners concerned with the necessity of checking insects or fungous troubles.

E. P. FELT

Current Notes

The European Corn Borer has been discovered in some districts in New Brunswick, Canada.

Mr. R. M. White, seasonal Junior Entomologist, Entomological Branch, terminated his appointment on October 31.

Mr. R. P. Gorham, of the Entomological Branch, recently gave a series of lectures at the Fredericton Agricultural School.

Dr. Daniel Ludwig has been appointed assistant professor of Entomology at Oklahoma College and assistant entomologist of the Station.

On November 19, Luther Brown, of the field laboratory at Sligo, Md., Bureau of Entomology, visited the Japanese Beetle Laboratory.

The appointment of Mr. Ellis McMillan, temporary Assistant Entomologist, Entomological Branch, has been extended six months dating from November 9th.

A. K. Wyatt, of Chicago, an entomologist interested in Lepidoptera, recently spent a few days at the Museum examining material with A. Busck.

The temporary appointments of R. W. McGinnis, Corvallis, Oreg., and H. L. Dees, Grand Bay, Ala., field assistants, Bureau of Entomology, have been terminated.

Rodney Cecil, Bureau of Entomology, in charge of the field laboratory at Geneva, N. Y., has been transferred to Columbus, Ohio, effective November 12.

V. V. Williams, Bureau of Entomology, left Tallulah November 5, to resume study of the Bucculatrix on cotton in the vicinitv of Calexico, Calif.

Professor George H. Lamson, head of the zoological department of the Connecticut Agricultural College has been appointed dean of the division of Agricultural Science.

Dean J. H. Skinner, of Purdue University, Lafayette, Ind., made a brief visit to the Washington office, Cereal and Forage Insect Investigations, on November 22.

Messrs. A. P. Arnason, temporary Junior Entomologist, and R. Glen, temporary Insect Pest Investigator, Entomological Branch, terminated their appointments on Oct. 15 and 27, respectively.

A. A. Mathewson, Bureau of Entomology, has been transferred from the corn borer field laboratory at Toledo, Ohio, to the field laboratory at San Antonio, Tex.

On November 2, John Glassford, Chief Chemist of McCormick and Company, Baltimore, Md., visited the Japanese Beetle laboratory to confer with E. R. Van Leeuwen.

Mr. W. H. Clarke, Assistant Entomologist, South Carolina Agricultural Experiment Station, is pursuing graduate work in entomology at Ohio State University during the winter term.

In mid-October, Mr. Wm. Mathers, Entomological Branch, made an aerial survey by hydroplane of epidemic insect infestations in lodgepole pine in the Okanagan Valley, B. C.

A. Salam Fauzy, Plant Quarantine Agent, of Alexandria, Egypt, and Max Kisliuk, Jr., Inspector from Philadelphia, of the Bureau of Entomology, visited the Japanese Beetle Laboratory November 15.

Mr. W. W. Stanley, Assistant Entomologist, Tennessee Experiment Station, is registered for graduate entomology work at Ohio State University during the winter term while on leave of absence.

Mr. A. M. Woodside, Assistant Entomologist, Virginia Polytechnique Institute, is on leave of absence during the winter term and is pursuing graduate work in entomology at Ohio State University.

Mr. Geo. R. Hopping of the laboratory at Vernon, B. C., Entomological Branch, recently made a survey of two new outbreaks of the hemlock looper in British Columbia.

M. T. Young, G. L. Smith, and R. W. Moreland, Bureau of Entomology, left Tallulah November 23 for Tucson, Ariz., where they will engage in scouting for Thurberia weevils.

After attending the annual meeting of the Entomological Society of Ontario at Guelph on Nov. 15 and 16, Mr. McLaine, Entomological Branch, visited the plant inspection offices at Toronto and Windsor.

On November 13 the Chicago, Rock Island and Pacific Railway Company obtained from Dr. Back, Bureau of Entomology, a deposition regarding facts relating to the biology of certain grain pests.

Dr. F. F. Russell, Director of the International Health Board, Rockefeller Foundation, together with Prof. Missiroli and three other Italian experts on malaria, called on November 15 to consult Dr. Dyar.

Frieda B. Hinnenkamp, a graduate of the University of Minnesota, has recently been given a probationary appointment as Junior Entomologist, Bureau of Entomology, at the field laboratory at Twin Falls, Idaho.

S. J. Snow, of the alfalfa weevil field laboratory, Bureau of Entomology, at Salt Lake City, was employed during the greater part of November investigating conditions in alfalfa meal mills at Ogden, Utah.

S. W. Bromley, formerly of the American Cyanamid Company of New York City has accepted the position, effective February 1, of Assistant Entomologist at the Bartlett Tree Research Laboratories located at Stamford, Conn.

Professor C. E. Sanborn, head of the department of Entomology, at the Oklahoma College and Station has recently been appointed acting dean of the School of Agriculture and acting director of the Station.

At the recent New York meetings the following were elected officers of the Entomological Society of America: President, C. T. Brues, Vice-President, H. B. Hungerford, Secretary-Treasurer, John J. Davis.

Mr. G. M. Stirrett has been spending much time in connection with the joint project with the Provincial Department regarding prelminary treatment and methods of ploughing corn stubble in corn borer clean-up work.

K. L. Cockerham, Bureau of Entomology, Biloxi, Miss., spent November 6 and 7 in Montgomery, Ala., in conference with officials of the State Department of Agriculture on the problem of the sweet potato weevil.

C. T. Blanz, Bureau of Entomology, who has been employed temporarily on control of the chestnut weevil in the Government chestnut orchard at Bell, Md., terminated his services for the Bureau on November 1.

Dr. H. L. Parker, of the Corn Borer Laboratory, Hyeres, France called at the National Mueusm November 20 to discuss with the Bureau Specialists various phases of his investigations, especially those dealing with hymenopterous parasites.

In the latter part of November, Claude Wakeland, Entomologist of the Idaho Agricultural Experiment Station, visited the field laboratory at Salt Lake City to confer with George I. Reeves, in charge of alfalfa weevil investigations.

In the first week of November, R. A. Blanchard, in charge of the field laboratory at Sacramento, Calif., Bureau of Entomology, made a trip into the Antelope Valley, on business relating to the alfalfa aphis.

Fred E. Brooks, Bureau of Entomology, in charge of the field laboratory at French Creek, W. Va., was in Washington on November 3 for a conference in relation to work on insects which are attacking chestnuts.

Charles F. Henderson, formerly an agent of the Truck Crop Division, Bureau of Entomology, on the sugar-beet leafhopper project, at Berkeley, Calif., has been appointed Assistant Entomologist, pending certification, and will be located at Twin Falls, Idaho.

Dr. Filippo Silvestri, of Portici, Italy, on his way home from the International Entomological Congress at Ithaca, and further travel in the United States, visited the European Corn Borer Parasite laboratory at Hyeres, Var, France, on November 16.

The annual public address of the Entomological Society of America,was delivered at Teachers College, Friday evening, December 28, by Dr. Royal N. Chapman of the University of Minnesota. He spoke upon the subject, "The Potentialities of Entomology."

Mr. W. J. Brown, Entomology Branch, has been promoted from assistant Entomologist to Entomologist dating from Nov. 1. The position now filled by Mr. Brown was formerly occupied by Mr. C. H. Curran who resigned on July 31, 1928.

On November 27, M. M. Darley, Bureau of Entomology, of the alfalfa weevil field laboratory, traveled by freight train from Ogden to Salt Lake City, to observe the reactions of adult weevils under the conditions obtaining in freight cars in motion.

Prof. Z. P. Metcalf, of the Zoology Department of North Carolina State College of Agriculture, at Raleigh, recently spent a week in the Museum studyng the collection of Hemiptera, with particular reference to recording specimens from the State of North Carolina.

A Survey of the cyclamen mite situation in the Ottawa district was carried out by Mr. A. G. Dustan in October and early November. The insectary at the Central Experimental Farm was closed for the winter in the latter part of November.

Late in November, Mr. Crawford visited Western Quebec where corn borer wintering experiments were established in fields at St. Martin de Laval, Farnham and Hemmingford. He also interviewed Mr. Hammond at the Hemmingford laboratory in connection with past and future investigational work.

At the meeting of the Entomological Club of Southern California held on September 19 at Alhambra, Dr. F. Silvestri of Italy, Mr. W. B. Gurney of New South Wales, Australia, and Mr. Bernard Trouvelot of France, were present and gave short talks.

Mr. M. Bernard Touvelot, Entomologist to the Versailles Institute of Research in Agriculture and Professor of Horticulture, who has spent almost a year in studying Entomological problems in the United States, has completed his work and is on his way back to France via Japan.

Dr. Herbert Osborn, Research Professor in Entomology at Ohio State University, left New York immediately following the Science meetings to spend the winter with his son, Herbert T. Osborn, who is in charge of the sugar plantation work in Central Aguirre, Porto Rico.

Everett C. Tatman, formerly a field assistant of the Truck Crop Division, Bureau of Entomology, working on the celery leaf-tyer at Sanford, Fla., has been appointed Assistant Scientific Aid, pending certification, and will continue his investigations at the field laboratory at Sanford.

At the 1928 Institute of California Fig Growers, held at Madera on October 25, Perez Simmons, Bureau of Entomology, in charge of the field laboratory at Fresno, was named to assist the 1929 Fig Institute Committee in preparing a program for the coming year.

Dr. H. J. Pack, for several years Entomologist for the Utah Station, has also been appointed acting head of the department of zoology and entomology in the college in place of Dr. W. W. Henderson, who has been granted leave of absence for one year.

Mr. Frank Hennessey, Artist, of the Entomological Branch, sailed for Europe on Nov. 21, on the S. S. Montrose. Mr. Hennessey plans to spend the winter months in Paris studying art. He will return to Canada and resume his duties at Ottawa early next spring.

Dr. Paul Marchal, one of our Foreign Members of many years standing, has been greatly honored in being made Vice-President of the Academy of Agriculture of France, a distinction which means that next year he will be the President of the Academy.

Mr. Perry A. Glick, assistant plant quarantine inspector stationed at the Tallulah (La.) cotton insect laboratory of the Bureau of Entomology, who was injured in an airplane crash in Mexico on September 17, has returned to duty from the United States Marine hospital, New Orleans.

W. H. W. Komp, of the United States Public Health Service, who is on his way to Almirante, Panama, to undertake under Dr. Barber studies relating to malaria, recently spent several days at the Museum studying the mosquitoes with which he is likely to deal there.

Dr. J. M. Swaine, Entomological Branch, during his voyage to Australia and New Zealand, visited the Fiji and Hawaiian Islands. Dr. J. D. Tothill, Government Entomologist at Suva, formerly of the Entomological Branch, Canada, was absent at that time and was in the Solomon Island.

Mr. H. A. Richmond, Entomological Branch, completed a forest insect inspection of the western slopes of the Rocky Mountains, south of the Canadian Pacific Railway and returned to the laboratory at Vernon, B. C. on Oct. 10. No epidemic infestations were discovered in the area under inspection.

Dr. S. B. Grubbs, of the United States Public Health Service, called November 19 to consult with Dr. Dyar in regard to the habits of the mosquito *Aedes aegypti*. The matter under consideration relates to the establishment of new rules for fumigating ships in the Canal Zone.

H. S. Peters, of the Division of Insects Affecting Man and Animals, Bureau of Entomology, visited the field laboratory at New Orleans on November 14 and with T. E. Holloway, in charge of that laboratory, made a number of inspections of dairy cattle for the ox warble.

On November 19, Dr. C. H. T. Townsend, of Lima, Peru, and formerly of the Bureau of Entomology arrived in Washington, and will spend a month examining genotypes of muscoid flies. He has recently made similar studies in the European museums, and has in progress a large work on this group.

On Oct. 18 the laboratory of the Entomological Branch at Lethbridge, Alta, was visited by Director Linfield of the Montana Experiment Station, Messrs. M. L. Willson and P. Carpenter, farm economists of the United States Department of Agriculture and I. D. O'Donnell, Director of Farm Research of the Great Northern Railroad.

Mr. O. E. Gahm has been transferred from the Mexican Bean Beetle Laboratory at Columbus, Ohio, to Arlington Farm, Va., where he will be in charge of the investigations on Mushroom Insects to be carried on in cooperation with Penn. State College and the disease investigations of the Bureau of Plant Industry.

Dr. Harry L. Parker, Bureau of Entomology, in charge of the European Corn Borer Parasite Laboratory, located at Hyeres, Var, France, is spending a brief time in America in consultation with the various officials with whom he is in constant correpondence relating to the collection, rearing, and distribution of parasites of the European corn borer.

Approximately 25,000 adults of the European corn borer parasite *Habrobracon* were liberated at Windsor, Ontario on November the 17th. No further liberations will be made this season. Breeding of the parasite *Exeristes* has been started and the spin-ups will be placed in cold storage. The egg parasite *Trichogramma* is being bred on a small scale.

After attending the annual meeting of the Entomological Society of Ontario at Guelph, Mr. H. G. Crawford, Entomological Branch, visited Mr. Hudson who is still in St. Joseph's hospital, London, Ont. recovering from a broken leg, and later consulted with the officers in charge of the laboratories at Strathroy and Chatham in regard to experimental work.

An Entomological Exhibit dealing principally with the European corn borer and fruit insects was shown at the Royal Winter Fair, in the Coliseum building of the Canadian National Exhibition, Toronto, Nov. 19–27. The exhibition was prepared and displayed under the direction of Mr. C. B. Hutchings assisted by Mr. P. I. Bryce of the Vineland laboratory, Entomological Branch.

The Treesbank laboratory, of the Entomolgical Branch, was closed for the winter on Nov. 15, and Mr. Norman Criddle arrived in Ottawa on Nov. 20. Mr. Criddle will spend the winter months assisting in the preparation of the Entomological Record for 1928, in consulting literature and in working over the data from his experimental studies conducted during the past season.

R. C. Mundell, of Brisbane, Australia, and E. Mortenson, of Texas engaged in investigations of insect enemies of the prickly pear in the Commonwealth of Australia, stopped in Washington November 15 to consult with W. S. Fisher and to obtain determinations of material. They were on their way to South America in search of insects destructive to the prickly pear cactus.

A corn borer conference was held at the State House, Providence, R. I., on December 10. Brief addresses were made by L. H. Worthley, A. E. Stene, W. E. Britton, Harry Horovitz, R. H. Allen, and Commissioners of Agriculture, H. R. Lewis of Rhode Island, A. W. Gilbert of Massachusetts, and assistant commissioner, C. P. Norgord, of New York.

The following entomologists from the citrus producing countries of the world that attended the International Congress of Entomology at Ithaca visited the University of California Citrus Experiment Station at Riverside: Dr. F. Silvestri of Italy, F. W. Pettey, of South Africa, W. B. Gurney of Australia. The Spanish representative, D. de Torres, had previously taken the summer course in citrus insects at Riverside.

Prof. W. J. Schoene, State entomologist of Virginia, and Professor of Entomology at the Virginia Polytechnic Institute and Prof. Robert K. Fletcher of Texas A. & M. College, completed their work for the degree of Doctor of Philosophy at

Ohio State University during the Autumn term of this year. The degrees were conferred upon these men at the autumn Convocation on December 22.

Dr. H. G. Dyar, well known Lepidoperist and a leader in the biology and taxonomy of mosquitoes, was stricken with paralysis and died at Washington, D. C., January 21. He was born in New York, February 14, 1866. Dr. Dyar was closely associated with Dr. L. O. Howard and the late Dr. Frederick Knab in the classic studies of the mosquitoes of North America and the West Indies. His List of North American Lepidoptera has superseded other lists and is today the one reference work in its field. Primarily a systematist, his researches have been of great value along the broader economic lines.

Following the meetings of the Entomological Society of Ontario the Dominion Entomologist, Arthur Gibson, visited Mr. H. F. Hudson, who is confined in the St. Joseph Hospital, London, Ont., and later continued on to Toronto where he visited the Plant Inspection Station and afterwards the Royal Winter Fair. On the evening of November 21, he attended the Annual Agricultural Dinner given by the Minister of Agriculture.

The furniture carpet beetle, *Anthrenus vorax*, has for years been reported only from Washington, D. C., but large numbers of this pest were found recently in house furnishings on their arrival in Chicago, after they had been stored for a considerable time in Washington. The incident is of interest as indicating how easily these insects may be carried from one part of the country to another.

Dr. H. W. Allen, of the Japanese Beetle Laboratory, Bureau of Entomology, who, with H. A. Jaynes, has recently made an intensive study of the eastern Asiatic species of Tiphia accumulated in the course of the work of collecting parasites of the Japanese beetle, was in the Museum November 1 and 2, and deposited a considerable series of specimens of the genus in the collection of Hymenoptera.

A. O. Larson, Bureau of Entomology, attended a convention of the California Horticultural Commissioners, recently held at Riverside, and gave a talk on bean weevils and their control. E. T. Hamlin, Horticultural Commissioner of Stanislaus County, Calif., discussed the part his organization has played in the campaign for the suppression of the bean weevil, in which the Bureau of Entomology and the California State and County representatives are cooperating.

Among the visitors at the parasite laboratory at Chatham, Ontario, during November were the following: Mr. D. M. Daniels from the laboratory at Fredonia, N. Y., Mr. E. L. Chambers, State Entomologist and Mr. W. A. Duffy, State Commissioner of Agriculture, Wisconsin, and Mr. H. L. Parker of the United States parasite laboratory at Hyeres, France, and Messrs. Luginbill and Baker of the United States Corn Borer laboratory at Monroe, Mich.

K. L. Cockerham, Biloxi, Miss., P. K. Harrison and M. Brunson, Picayune, Miss., F. A. Wright, Bay St. Louis, Miss., and S. C. Brummitt, Grand Bay, Ala., all of the Bureau of Entomology, conferred with the workers of the Mississippi State Plant Board at A. & M. College, November 26 to 28, on the problem of eradicating the sweet potato weevil in Mississippi. Plans were made for completing the work in this line.

J. M. Miller, Bureau of Entomology, made a field trip to the Prescott National Forest in November to check up the results of a control project which was conducted last winter and spring against an increasing infestation of *Dendroctonus barberi* Hopk. This is the first control project ever attempted against this species of *Dendroctonus*.

The first year's results have been highly satisfactory, and it is recommended that the work be extended next year.

The meeting of West Texas Pecan Growers at Brownwood, November 15 and 16, was well attended and considerable interest in the Bureau's pecan insect work was manifested. Unfortunately, bad weather prevented a number from visiting the Bureau's laboratory at Brownwood who would have liked to do so. At this meeting, Mr. H. S. Adair, Bureau of Entomology, of the field laboratory, gave a talk on "Some Practical Methods of Controlling Injurious Pecan Insects of this Section."

According to *Science*, Dr. W. V. King, of the Bureau of Entomology, who has been engaged in mosquito work at Mound, La., has an appointment from the International Health Board to visit the Philippine Islands for the purpose of making a special study of mosquitoes in the islands. He expects to spend several months in the Islands and will bring his material to the U. S. National Museum for final study in conjunction with Dr. H. G. Dyar.

The sixty-fifth annual meeting of the Entomological Society of Ontario was held at the Ontario Agricultural College, Guelph, Nov. 15 and 16, the following Branch officers attended many of whom presented papers, Messrs. Arthur Gibson, L. S. McLaine, H. G. Crawford, W. A. Ross, W. G. Garlick, T. Armstrong, A. R. Graham, A. B. Baird, D. F. Patterson, L. J. Briand, G.M. Stirrett; George Wishart, C. W Smith, W. A. Steenburgh, W. A. Fowler, R. W. Sheppard, and A. A. Wood.

Up to November 20, A. O. Larson and C. K. Fisher of the field laboratory at Modesto, Calif., Bureau of Entomology, and their assistants handled during the bean harvest just ended, in and about Modesto, 3,177 samples of beans, sent them for inspection. During the harvest of 1927 they handled 1,967 such samples. The greater amount of work in this line in the present season is indicative of the increasing sentiment among bean growers in favor of the present method of control.

C. W. Collins, Bureau of Entomology, was in Washington November 21 to 23, conferring with members of the Bureau of Entomology, and especially with Dr. F. C. Craighead, in charge of the Division of Forest Insects, regarding the work of the Gipsy Moth Laboratory. Mr. Collins, while on this trip stopped in New Jersey to confer with Dr. R. W. Glaser, of the Rockefeller Institute for Medical Research, and H. A. Ames, of the Plant Quarantine and Control Administration, regarding investigational work on the gipsy moth.

W. H. Larrimer, in charge of the Division of Cereal and Forage Insect Investigations, Bureau of Entomology, and D. J. Caffrey, of the same division, visited the Gipsy Moth Laboratory on October 24. Other recent visitors to this laboratory were M. F. Crowell, of North East, Pa., on November 7, R. G. Smith, Inspector of the Plant Quarantine and Control Administration, stationed in New York City, on November 16, E. G. Woodward Agent in Blister Rust Control, Warrenburg, N. Y., Raymond Paige, Fort Ann, N. Y., and W. S. Codman, Eldred, N. Y. on November 21.

The second consignment of eggs of the Angoumois grain moth, *Sitotroga cerealella*, to the Barbados Department of Agriculture, for use in rearing Trichogramma parasites of the sugar-cane moth borer, *Diatraea saccharalis*, was shipped from New York, November 24 on the S. S. Voltaire. The eggs were obtained at the field laboratory at Sligo, Md., by C. W. Ellington, who took them to New York and placed them on board the steamer. They were to have been shipped on the S. S.

Vestris, which was sunk November 12, fortunately, the difficulty of obtaining these eggs so late in the season caused a delay which resulted in preventing their loss.

On November 23, 1928 a group of entomologists of Texas, representing the state, the federal government, and institutions of higher learning, met at Austin, Texas to formally organize the Texas Entomological Society. The following officers were elected: President—S. W. Bilsing, Head Department of Entomology, Texas A. & M. College, College Station, Texas. Vice-President—R. E. McDonald, Chief Entomologist, State Department of Agriculture, Austin, Texas. Secretary-Treasurer—M. A. Stewart, The Rice Institute, Houston, Texas. It was voted at this meeting to hold the next meeting in Houston, Texas on February 5, 1929, immediately preceding the meetings of the Cotton States Branch of the American Association of Economic Entomologists.

The seventh annual meeting of the Entomological Society of Pennsylvania was held at Harrisburg, Pa., on January 22nd in conjunction with the State Farm Products Show. The Japanese beetle was discussed by C. H. Hadley and R. H. Bell. H. N. Worthley spoke on the European corn borer, T. L. Guyton and C. H. Hadley spoke on Asiatic beetles, C. C. Hill on the Hessian fly and F. M. Trimble on nursery inspection. Dinner was served in the evening aftr which C. H. Hogkiss spoke on the problems of an extension entomologist, and Dr. E. N. Cory discussed the workings of the Eastern Plant Board. The meeting was attended by the following: P. T. Barnes, R. H. Bell, A. W. Buckman, A. B. Champlain, Dr. E. N. Cory, H. J. Fisher, E. M. Gress, Dr. T. L. Guyton, C. H. Hadley. C. C. Hill, H. E. Hodgkiss, F. L. Holdridge, J. N. Knull, W. A. McCubbin, G. F. MacLeod, J. O. Pepper, W. E. Phillips, J. S. Pinckney, G. E. Sanders, S. D. Semenow, G. B. Stichter, F. M. Trimble and H. N. Worthley.

A beautiful tribute was paid to the life and work of the late Dr. E. A. Schwarz by the following statement placed in the minutes of the Entomological Society of Washington.

"The Entomological Society of Washington appreciates to the fullest degree that in the passing of Dr. Eugen Amandus Schwarz it has lost its most learned member, its most loyal and generous supporter and the kindliest and most helpful of friends. The society points with pride to the facts that Doctor Schwarz was one of its founders, that he held in the course of the years every office in which he could serve and the title of Honorary President was created especially for him. The society feels that American Entomologists should be grateful that this great soul has lived among them for more than fifty years, constantly in his quiet way influencing their trend of thought towards the very best methods and towards sound scholarship."

Dr. Claude Fuller, Entomologist of the Portuguese East Africa Department of Agriculture died November 5th at Lourenco Margues, P. E. A. from injuries suffered in an automobile accident the previous day. Dr. Fulller was born in New South Wales in 1872 and at the age of 18 began work under Dr. N. A. Cobb then vegetable pathologist in the department of Agriculture N. S. W. Later he worked with A. S. Olliff, entomologist, and six years later with the Western Australian department of Agriculture before joining the Cape Colony Dept. of Agriculture as assistant to Dr. C. P. Lounsbury. In 1899 he became government Entomologist of Natal and after unification of the four South African colonies in 1910, became assistant chief of the Division of Entomology under Dr. Lounsbury at the time of whose resignation he became Chief, which position he held until reaching the age of superannuation. Since that time he has held the position of Entomologist of Portuguese East Africa, until the time of his death.

By invitation of Director G. H. Hecke, of the California State Department of Agriculture, dated November 15, Perez Simmons, Bureau of Entomology, has become a member of the "California Clean-Up Committee," an organization for dealing with pests affecting the fig industry. E. A. McGregor, in charge of the field laboratory at Lindsay, Calif., for the study of citrus insects, and W. S. Ballard, of the Bureau of Plant Industry, who is located at Fresno, are other representatives of the Department of Agriculture on this committee. W. C. Jacobson, of the Bureau of Plant Quarantine and Pest Control of the California State Department of Agriculture, is chairman, and John W. Guyler, of the Advisory Board, California Peach and Fig Growers, Inc., is secretary of the committee. The University of California is represented by Ira J. Condit, Associate in Subtropical Horticulture, Agricultural Experiment Station, Leroy B. Smith, Assistant State Leader (southern counties), Extension Service, and Ralph E. Smith, Head of the Division of Plant Pathology. Other members of the committee are Fred P. Rouillard, Horticultural Commissioner, Fresno County, Frank R. Brann, Horticultural Commissioner, Tulare County, Dwight K. Grady, Secretary of the Dried Fruit Association of California, Ward B. Minturn, President of the California Peach and Fig Growers, Inc., O. G. Brundage, fruit grower, and W. W. Bacon, Superintendent of the Forkner Fig Gardens.

Doctor J. M. Swaine, Entomological Branch, returned to Ottawa on Nov. 19 from the Empire Forestry Conference in Australia and New Zealand. The tour of the Conference in Australia covered most of the forest types in that country with the exception of the subtropical forests in the extreme north. The Conference opened at Perth in Western Australia and, after visits to the Karri and Jarrah forests of that state, crossed the desert to South Australia, visited the eucalyptus forests of that region; and continued through those of Victoria, including the magnificent moutain ash forests of the Cumberland valley. The Conference spent a week in Tasmania and returning to Melbourne, travelled across New South Wales, visiting a series of forests in the northeastern part of the state. A short time was spent in the forests of the southern half of Queensland, and during that time Doctor Swaine left the Conference to visit one of the principal stations for the distribution of prickly pear insects at Chinchilla in the interior of the state. Some three million acres of land in south Queensland and north New South Wales has been covered by the prickly pear and recently it was spreading at an alarming rate, a large part of the area covered by it being rendered useless for any purpose. Owing to the introduction of insects from South America, which are rapidly destroying the cacti, it appears that the problem is on the way to solution and that the methods now being adopted will succeed in controlling the cactus within the next generation.

Doctor Swaine visited as many entomological laboratories and museums as possible and met a number of Australian and New Zealand entomologists, including Mr. Froggat of Sydney, Mr. French of Melbourne, Mr. Lea of Adelaide, Doctor Tillyard and Mr. Hill of the Australian federal service, Doctor Millar, of the Cawthron Institute and their associates.

Dr S. W. Frost spent the greater part of Jan. 13 with Dr. Roger C. Smith at Port-au-Prince, Haiti. Dr. Frost was enroute to Panama.

Dr. Roger C. Smith, head of the department of Entomology and Zoology of the Service Technique, Port-au-Prince, Haiti, has been made Director of the Ecole Centrale. This is the agricultural college or training school part of the Service Technique. He retains the headship of the Entomology department also.

Dr. T. J. Naude was appointed Chief Entomologist of the Union of South Africa, following the retirement September 30, 1927 of Dr. Claude Fuller.

Conferences were held in Washington, D. C., January 3, 1929, at the Bureau of Entomology, on the Codling Moth and Peach Moth. The following were present: C. Graham, H. S. McConnell, W. T. Henerey, and E. N. Cory, Univ. Md.; W. S. Hough, Va. Agr. Exp. Sta.; George A. Dean and L. E. Call, Kan. Agr. Coll.; C. H. Alden and M. S. Yeomans, Ga. State Bd. Ent.; R. H. Robinson, Ore. Agr. Coll.; M. P. Jones, Ohio State Univ.; J. S. Houser and Louis A. Stearns, Ohio Agr. Exp. Sta.; Bynley F. Driggers, N. J. Agr. Exp. Sta.; T. L. Guyton, H. E. Hodgkiss, and H. N. Worthley, Pa. Agr. Exp. Sta.; H. L. Dozier, Del. Agr. Exp. Sta.; Philip Garman, Conn. Agr. Exp. Sta.; W. P. Flint, Univ. Ill.; J. J. Davis, Purdue Univ.; R. H. Pettit, Mich. Agr. Coll.; P. J. Parrott, N. Y. Agr. Exp. Sta.; W. A. Ross, Ont. Agr. Coll.; R. B. Arnold and M. D. Leonard, Tobacco By-Products & Chem. Corp.; J. A. Landes, Stand. Oil Co.; W. S. Regan, Calif. Spray Chem. Co.; A. L. Quaintance (*Chairman*), Paul M. Gilmer, J. A. Hyslop, N. E. McIndoo, L. C. McAlister, Jr., R. F. Sazama, Loren B. Smith, B. A. Porter, Luther Brown, E. H. Siegler, E. R. Van Leeuwen, A. J. Ackerman, G. J. Haeussler, J. W. Lipp and F. H. Lathrop, U. S. Bur. of Ent.; M. B. Waite, U. S. Bureau Plant Ind. and R. C. Roark, U. S. Bur. Chem. & Soils.

Minutes of the conferences will be issued in mimeographed form and sent to those in attendance. Upon request the minutes will also be sent to others interested as long as the supply lasts

Apicultural Notes

Dr. Warren Whitcomb, Jr., Bureau of Entomology, of the Southern States Bee Culture Field Laboratory, Baton Rouge, La., attended the meeting of the Georgia State Beekeepers' Association at Macon, Ga., on Sept. 19, where he outlined the work of that laboratory. He also attended the meeting of the Alabama State Beekeepers' Association, at Montgomery, on November 14. On November 15 a field meeting was held at Andalusia, Ala., where members of the Association inspected the bee-supply plant of the Andalusia Manufacturing Company. Doctor Whitcomb reports that the meeting was well attended, and that great interest was manifested in the establishment of United States standards for package bees.

Dr. A. P. Sturtevant and J. E. Eckert, Bureau of Entomology, of the Intermountain Bee Culture Field Laboratory, Laramie, Wyo., attended the meeting of the Colorado Beekeepers' Association, at La Junta, on November 13 and 14. Doctor Sturtevant spoke before the meetings of the Montana State Beekeepers' Association, held at Billings, Mont., on November 19 to 21; and the Wyoming State Beekeepers' Association, at Thermopolis, held November 22 to 24. Mr. Eckert also attended the meeting of the recently organized Colorado-Wyoming Academy of Science, held at the University of Denver on November 30.

The past summer, Dr. R. L. Parker assisted in conducting several Farm and Home Week programs and Beekeepers Short Courses as follows: Short course at the University of Missouri at Columbia, July 16 to 18; Farm and Home Week program at the Massachusetts Agricultural College, Amherst, July 26; Farm and Home Week program at the Connecticut Agricultural College, Storrs, July 31. On Sept. 1, 1928, at the Nebraska State Fair, Lincoln, Nebr. he judged the honey exhibit and on

Sept. 13, at the Kansas Free Fair, Topeka, Kansas, gave a talk on the subject "Honey as a Food." At present he is the Superintendent of Bees and Honey for the Kansas State Fair at Hutchinson, Kans.

The use of formaldehyde gas for disinfecting combs infected with American foulbrood has been recommended rather strongly during the last year in a number of articles appearing in some of the bee journals. Years ago Dr. G. F. White, of the Bureau of Entomology, tried formaldehyde gas for disinfecting American foulbrood combs. Although he found that it was possible to kill the spores of *Bacillus larvae* with the gas, no practical method presented itself for subjecting the combs to treatment which gave uniform results and therefore the hope of devising a method that could be used by the beekeeper was at least temporarily abandoned. The articles referred to, however, have stimulated a great many beekeeprs to use formaldehyde gas in an effort to disinfect combs infected with foulbrood. Practically all samples of combs which have been subjected to the gas, and afterwards submitted to the Bee Culture Laboratory for culturing, indicate that sterility is by no means complete, and that the method as it has been advocated by a few beekeepers can not be recommended.

Horticultural Inspection Notes

J. P. Kislanko, Inspector, Mississippi, for the State Plant Board, who has for several years made his headquarters at Ocean Springs, Mississippi, has been transferred to Wiggins, Mississippi, where he will have charge of all Plant Board work in Stone County and in the western part of George County.

The work at the new inspection offices, Canadian Entomological Branch, is now well established and the following officers have been permanently appointed as district inspectors at the inspection stations indicated: Mr. A. K. Gibson, Halifax, N. S.; Mr. C. S. Thompson, Windsor, Ontario, Mr. C. A. S. Smith, Winnipeg, Man., Mr. P. C. Brown, Estevan, Sask.

A conference was held at Washington, D. C., December 4, regarding the quarantines on Japanese and Asiatic beetles. The following men were present: Dr. C. L. Marlatt, S. A. Rohwer, R. C. Althouse, J. E. Graf, L. B. Smith, C. H. Hadley, C. W. Stockwell, Dr. W. E. Britton, Connecticut; J. F. Adams, Delaware; C. N. Cory, T. B. Symons, Maryland; R. H. Allen, Massachusetts; H. B. Weiss, New Jersey; B. D. Van Buren, New York; R. H. Bell, Pennsylvania; G. T. French, Virginia.

The annual meeting of the Mississippi State Plant Board was held at A. & M. College on November 26, 27, and 28. Among the visitors who participated in the program were: J. B. Demaree, Bureau of Plant Industry, Thomasville, Georgia, James Silver, Bureau of Biological Survey, Washington, D. C., J. A. Harris, State Department of Agriculture, Raleigh, North Carolina, S. J. Greer, Director, Pecan Experiment Station, Natchez, Mississippi, J. C. Holton, Commissioner of Agriculture, Jackson, Mississippi, J. R. Ricks, Director of the Mississippi Experiment Stations, J. C. C. Price, L. F. Ware, and Lyle Brown of the Horticultural Department of the Mississippi A. & M. College, and the following representatives of the United States Bureau of Entomology: K. L. Cockerham, Biloxi, Mississippi, S. C. Brunmitt, Grand Bay, Alabama, F. A. Wright, Bay St. Louis, Mississippi, P. K. Harrison and M. Brunson, Picayune, Mississippi. State Plant Board workers participating were: R. W. Harned, L. E. Miles, H. H. Kimball, George F. Arnold, Clay

Lyle, J. M. Langston, R. N. Lobdell, M. R. Smith, J. G. Hester, H. H. Wedgeworth, T. F. McGehee, R. P. Colmer, O. M. Chance, R. B. Deen, H. H. Carpenter, H. Gladney, Jack Milton, M. L. Grimes, N. D. Peets, W. L. Gray, J. E. Lee, J. P. Kislanko, J. E. McEvilly, G. I. Worthington, F. P. Amsler, F. A. Smith, Chesley Hines, N. L. Douglass, D. W. Grimes, J. M. Foley, L. J. Goodgame, S. S. Sheffield, W. Gavin, O. S. Redden, J. L. Tate, J. A. Brown, and E. H. Gibbons. Among the subjects discussed at length were: sweet potato weevil eradication in Alabama and Mississippi, Argentine ant control and eradication in Mississippi, boll weevil hibernation studies, pecan insects and diseases, peach insects, rat control campaigns, inspection of nurseries, sweet potatoes, and apiaries, and quarantine work. Papers were received from Dr. T. E. Snyder of the Bureau of Entomology on "Termite Control," and from Dr. W. E. Hinds, Entomologist of the Louisiana Experiment Station, on "The Utilization of *Trichogramma minutum* in Insect Control."

Notes on Medical Entomology

E. C. Cushing, Bureau of Entomology, spent the month of October in making a mosquito survey of northern Florida.

W. V. King, Bureau of Entomology, in charge of the field laboratory at Mound, La., went from there to Washington about the middle of November to confer with the Chief of the Bureau.

D. C. Parman, Bureau of Entomology, of the field laboratory at Uvalde, Tex., who has spent several weeks in California studying control measures for the sand fly *Hippelates flavipes*, returned to Uvalde, November 24.

Three Russian Entomologists, A. P. Adrianov, Senior Specialist, Bureau of Plant Protection, V. V. Nikolsky, Entomologist, Interdepartmental Quarantine Commission, and J. A. Parfentier, Entomologist Insecticide and Fungicide laboratory, all of the U. S. S. R., visited the office of Dr. F. C. Bishopp on October 3.

For the purpose of testing a number of insecticides in control of cattle grubs, the available field men in the Bureau of Entomology were concentrated at Dallas, Tex., in the latter part of November, for work during the month of December. H. S. Peters and R. W. Wells, of the field laboratory at Beltsville, Md., E. C. Cushing, of the field laboratory at Mound, La., and W. G. Bruce of the one at Fargo, N. D., are the men engaged in this work.

Dr. W. V. King, of the Bureau of Entomology, who has been engaged in mosquito work at Mound, La., visited the Museum November 10 to study species of the genus Anopheles. Dr. King has an appointment from the International Health Board to visit the Philippine Islands, where he is to make a special study of mosquitoes of this genus. He will spend several months in field work in the Islands, and will then return for a critical study of his material.

On November 13, F. C. Bishopp, Bureau of Entomology, left Washington for Dallas, Tex., to confer with the investigators in the field laboratory there and aid in the planning of work to be conducted in the near future. During the following two weeks he visited the field laboratories at Sonora and Uvalde, and conferred with authorities of the Texas Experiment Station in Sonora and the representatives of the Plant Quarantine and Control Administration and the Biological Survey in San Antonio.

Visitors during the month of November at the Washington office, Division of Insects affecting man and animals included Professor C. E. Sanborn, Entomologist

of the Oklahoma Experiment Station, Dr. Edward Francis, of the U. S. Public Health Service, and Messrs. Mondell and Mortenson, agents of the Australian Prickly Pear Board. The two last named were on their way to South America, Mr. Mortenson to Brazil and Mr. Mondell to Peru, for the purpose of scouting for promising cactus insects. Incidentally, their intention had been to book passage on the ill-fated S. S. Vestris, but they were unable to get ready for departure by the time the vessel sailed.

A meeting with a huge barbecue, roping contest, and other typically western entertainments was held at the Devils River Ranch of Congressman Claude Hudspeth, 30 miles north of Comstock, Tex., on November 17. The meeting was called to discuss ways and means of reducing losses from the screw worm and wool maggots. About 1,000 representative ranchmen of western Texas were present. Secretary Jardine and Dr. Mohler were invited to address the gathering, but neither could be present. F. C. Bishopp represented the Bureau of Entomology, and discussed the work which the Bureau has been doing in developing measures for control of the screw worm. O. G. Babcock also attended the meeting.

Corrigenda

In the article by Frank T. Cowan, Arsenites for the Control of the Mormon Cricket, in Vol. 21, No. 6, of the Journal of Economic Entomology, on page 930, first line, second paragraph, this should read: "Under the direct supervision of W. B. Mabee," etc., instead of "With the assistance of."